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DRAFT ZONE E RESOURCE CONSERVATION AND RECOVERY FACILITY INVESTIGATION REPORT VOLUME VI OF XV SECTIONS 10.41 TO 10.50 CNC CHARLESTON SC

11/1/1997

ENSAFE

DRAFT ZONE E
RCRA FACILITY INVESTIGATION REPORT
NAVBASE CHARLESTON

VOLUME VI OF XV
SECTIONS 10.41 to 10.50

CTO-029
CONTRACT NO: N62467-89-D-0318

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

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10.41 AOC 583, Northeast Corner of Building 236

AOC 583 comprises the activities conducted in the northeast corner of Building 236 which was constructed in 1982. The north side of the building houses conference rooms, offices, a locker room, and a pipe-fitting shop. The shop area contains a Freon recycling and distillation unit, associated piping, and three USTs. Five additional USTs containing petroleum products are located outside the northeast corner of the building. In 1986, approximately 200 gallons of rinsate-containing paint stripper were discharged outside the northeast end of the building to the storm drain.

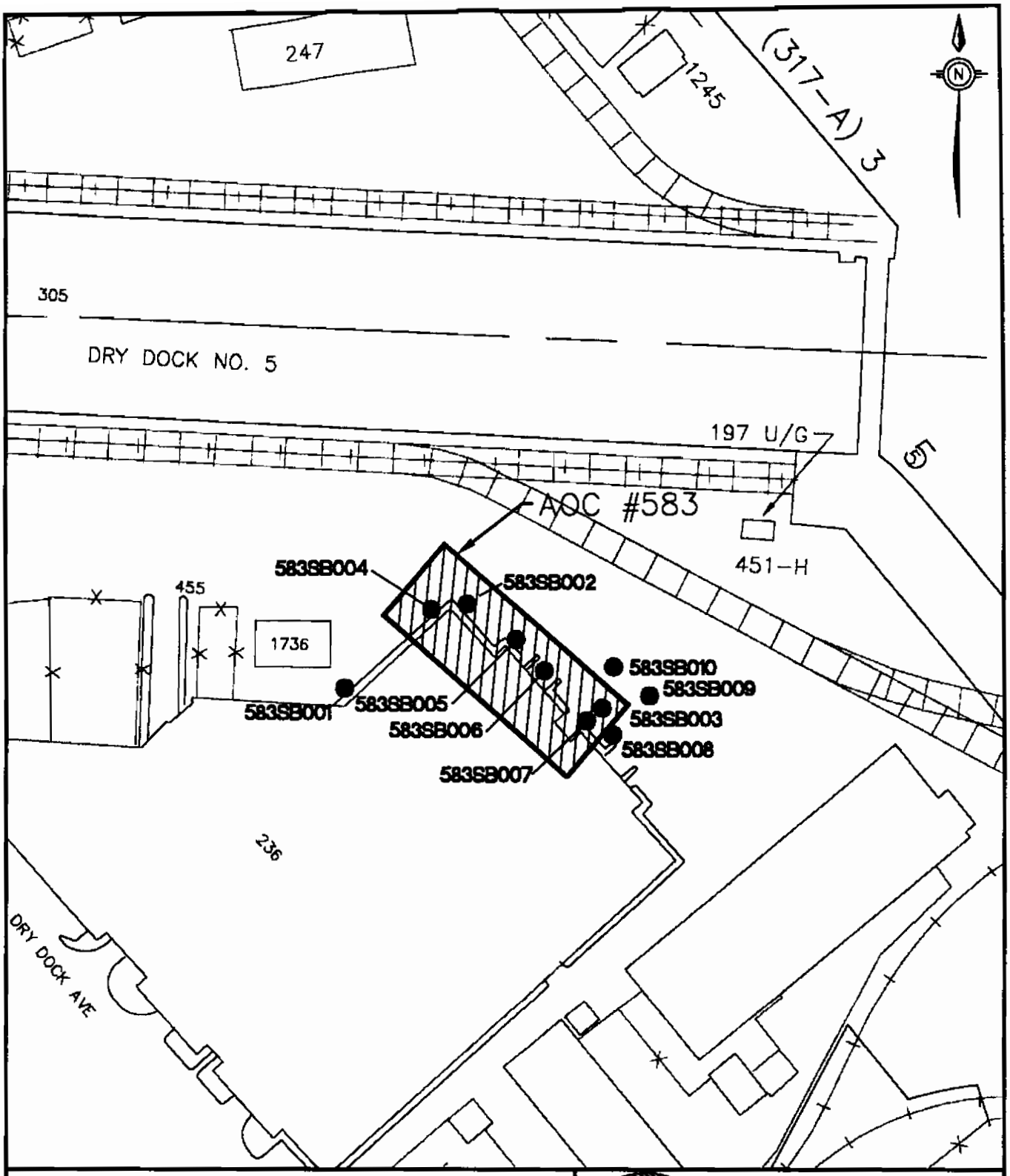
Materials of concern identified in the *Final Zone E RFI Work Plan* include Freon, paints, solvents, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI objectives for AOC 583, soil and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan* (E/A&H, June 1995) and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.41.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 583 from the locations shown in Figure 10.41.1. The *Final Zone E RFI Work Plan*, proposed collecting four soil samples from the upper interval and four samples from the lower interval. Soil samples were also collected at both intervals for the three shallow monitoring well locations proposed at this site.

First-round Sampling — During the first round of sampling, all seven proposed upper- and lower-interval samples were collected.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.41.1
SOIL BORING LOCATIONS
AOC #583
BUILDING
236

DWG DATE: 09/02/97 | DWG NAME: 10-41-1

First-round samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. One upper-interval sample selected as a duplicate was analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the requested suite of parameters plus a more comprehensive list of VOCs, SVOCs, as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.41.1.1 summarizes the first round of soil sampling at AOC 583.

Table 10.41.1.1
AOC 583
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	7	7	VOC, SVOC, and metals	VOC, SVOC, and metals	None
Lower	7	7	VOC, SVOC, and metals	VOC, SVOC, and metals	None

Second-round Sampling — Second-round sampling was performed at AOC 583 after first-round analytical results were compared to the USEPA Region III RBCs and SSLs (April 1996). Parameters exceeding RBCs and SSLs included SVOCs. Section 10.41.2 details specific parameters and locations which exceeded RBCs.

The second round included three upper- and three lower-interval samples to determine the extent of constituents detected during first-round sampling. Two of three proposed upper-interval samples and one of three lower-interval samples were collected. One upper-interval and lower-interval sample could not be collected due to surface obstructions at that particular sample location. One lower-interval sample could not be collected due to subsurface obstructions such as wood or rocks.

Second-round samples at AOC 583 were submitted for analysis of VOCs, SVOCs, and metals. No duplicate samples were collected during the second round of sampling. Table 10.41.1.2 summarizes the second round of soil sampling at AOC 583.

Table 10.41.1.2
AOC 583
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	3	2	VOC, SVOC, and metals	VOC, SVOC, pesticide, cyanide, and metals	One sample could not be collected due to surface obstructions; one sample inadvertently analyzed for pesticides and cyanide
Lower	3	1	VOC, SVOC, and metals	VOC, SVOC, pesticide, cyanide, and metals	Two samples could not be collected due to surface and subsurface obstructions; one sample inadvertently analyzed for pesticides and cyanide

10.41.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.41.2.1. Inorganic analytical results for soil are summarized in Table 10.41.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.41.2.1
AOC 583
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (µg/kg)						
Acetone	Upper	2/8	82.0 - 93.0	87.5	20,000,000	0
	Lower	4/8	24.0 - 110	60.0	NA	NA

Table 10.41.2.1
AOC 583
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Carbon disulfide	Lower	1/8	33.0	33.0	NA	NA
Methylene chloride	Upper	4/8	2.00 - 28.0	15.3	760,000	0
	Lower	5/8	2.00 - 37.0	14.8	NA	NA
1,2,4-Trichlorobenzene	Upper	1/9	38.0	38.0	2,000,000	0
SVOCs (μg/kg)						
Acenaphthene	Upper	1/9	160	160	12,000,000	0
	Lower	1/8	89.0	89.0	NA	NA
Anthracene	Upper	2/9	79.0 - 110	94.5	61,000,000	0
	Lower	2/8	45.0 - 500	273	NA	NA
Benzo(g,h,i)perylene	Upper	5/9	46.0 - 220	110	8,200,000	0
	Lower	3/8	47.0 - 2,600	912	NA	NA
Benzoic acid	Upper	4/9	64.0 - 210	110	100,000,000	0
	Lower	5/8	85.0 - 420	268	NA	NA
bis(2-Ethylhexyl)phthalate	Upper	1/9	40.0	40.0	410,000	0
	Lower	1/8	38.0	38.0	NA	NA
Carbazole	Upper	1/1	82.0	82.0	290,000	0
Dibenzofuran	Lower	1/8	59.0	59.0	NA	NA
Diethylphthalate	Lower	1/8	42.0	42.0	NA	NA
Fluoranthene	Upper	6/9	56.0 - 800	313	8,200,000	0
	Lower	3/8	210 - 3,400	1,300	NA	NA
Fluorene	Upper	1/9	71.0	71.0	8,200,000	0
	Lower	1/8	180	180	NA	NA
4-Methylphenol (p-Cresol)	Lower	1/8	51.0	51.0	NA	NA

Table 10.41.2.1
AOC 583
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Naphthalene	Upper	1/9	58.0	58.0	8,200,000	0
4-Nitrophenol	Upper	1/9	55.0	55.0	13,000,000	0
N-Nitroso-di-n-propylamine	Upper	1/9	47.0	47.0	820	0
Pentachlorophenol	Upper	1/9	59.0	59.0	48,000	0
Phenanthrene	Upper	5/9	65.0 - 680	270	8,200,000	0
	Lower	3/8	140 - 1,700	690	NA	NA
Pyrene	Upper	5/9	150 - 740	402	6,100,000	0
	Lower	3/8	230 - 6,400	2,330	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	5/9	101 - 469	250	780	0
	Lower	3/8	118 - 5,990	2,110	NA	NA
Benzo(a)anthracene	Upper	5/9	75.0 - 260	162	7,800	0
	Lower	3/8	96.0 - 4,100	1,450	NA	NA
Benzo(b)fluoranthene	Upper	5/9	77.0 - 290	167	7,800	0
	Lower	3/8	97.0 - 3,300	1,170	NA	NA
Benzo(k)fluoranthene	Upper	5/9	94.0 - 310	177	78,000	0
	Lower	3/8	100 - 3,000	1,080	NA	NA
Benzo(a)pyrene	Upper	5/9	81.0 - 300	170	780	0
	Lower	3/8	93.0 - 3,700	1,310	NA	NA
Chrysene	Upper	5/9	98.0 - 340	216	780,000	0
	Lower	3/8	130 - 4,400	1,580	NA	NA
Dibenz(a,h)anthracene	Upper	3/9	40.0 - 95.0	61.0	780	0
	Lower	2/8	47.0 - 1,300	674	NA	NA

Table 10.41.2.1
AOC 583
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Indeno(1,2,3-cd)pyrene	Upper	5/9	40.0 - 160	86.2	7,800	0
	Lower	3/8	42.0 - 2,200	769	NA	NA
Pesticides/PCBs (μg/kg)						
4,4'-DDE	Lower	1/1	3.90	3.90	NA	NA
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	1/1	0.309	0.309	1,000	0
1234678-HpCDD	Upper	1/1	11.6	11.6	NA	NA
1234678-HpCDF	Upper	1/1	3.32	3.32	NA	NA
OCDD	Upper	1/1	151	151	NA	NA
OCDF	Upper	1/1	8.17	8.17	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.41.2.2
AOC 583
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	9/9	3,740 - 14,000	6,700	100,000	26,600	0
	Lower	8/8	1,590 - 16,200	7,990	NA	41,100	NA
Antimony (Sb)	Upper	4/9	0.440 - 3.50	1.35	82.0	1.77	0
	Lower	3/8	0.690 - 3.90	1.80	NA	1.60	NA

Table 10.41.2.2
AOC 583
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Arsenic (As)	Upper	9/9	0.760 - 5.10	3.27	3.80	23.9	0
	Lower	7/8	4.10 - 9.50	6.90	NA	19.9	NA
Barium (Ba)	Upper	9/9	14.2 - 33.2	21.2	14,000	130	0
	Lower	8/8	3.90 - 41.9	24.2	NA	94.1	NA
Beryllium (Be)	Upper	9/9	0.150 - 0.440	0.294	1	1.70	0
	Lower	7/8	0.210 - 0.760	0.429	NA	2.71	NA
Cadmium (Cd)	Upper	3/9	0.110 - 0.170	0.130	100	1.50	0
Calcium (Ca)	Upper	9/9	6,110 - 26,400	16,100	NA	NA	NA
	Lower	8/8	301 - 16,700	7,270	NA	NA	NA
Chromium (Cr)	Upper	9/9	9.80 - 179	56.2	1,000	94.6	0
	Lower	8/8	2.10 - 34.7	19.0	NA	75.2	NA
Cobalt (Co)	Upper	9/9	1.000 - 3.80	2.03	12,000	19.0	0
	Lower	8/8	0.270 - 4.40	2.11	NA	14.9	NA
Copper (Cu)	Upper	9/9	2.20 - 22.8	14.2	8,200	66.0	0
	Lower	8/8	0.480 - 14.3	5.04	NA	152	NA
Iron (Fe)	Upper	9/9	2,230 - 12,000	5,790	61,000	NA	0
	Lower	8/8	752 - 31,100	13,800	NA	NA	NA
Lead (Pb)	Upper	9/9	5.00 - 39.8	23.2	1,300	265	0
	Lower	8/8	1.60 - 41.9	~~15.5~~ OK	NA	173	NA
Magnesium (Mg)	Upper	9/9	460 - 3,130	1,960	NA	NA	NA
	Lower	8/8	115 - 1,980	1,340	NA	NA	NA

Table 10.41.2.2
AOC 583
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Manganese (Mn)	Upper	9/9	22.1 - 238	94.7	4,700	302	0
	Lower	8/8	3.70 - 153	69.0	NA	881	NA
Mercury (Hg)	Upper	7/9	0.0200 - 0.1000	0.0614	61	2.60	0
	Lower	4/8	0.0300 - 0.120	0.0750	NA	1.59	NA
Nickel (Ni)	Upper	9/9	2.20 - 7.80	5.11	4,100	77.1	0
	Lower	8/8	0.700 - 7.70	4.31	NA	57.0	NA
Potassium (K)	Upper	9/9	236 - 1,150	579	NA	NA	NA
	Lower	7/8	430 - 1,670	876	NA	NA	NA
Selenium (Se)	Lower	2/8	1.10 - 1.20	1.15	NA	2.40	NA
Silver (Ag)	Lower	1/8	0.390	0.390	NA	NA	NA
Sodium (Na)	Upper	7/9	158 - 353	263	NA	NA	NA
	Lower	6/8	174 - 402	297	NA	NA	NA
Thallium (Tl)	Lower	2/8	0.670 - 1.000	0.835	NA	NA	NA
Tin (Sn)	Upper	1/9	2.90	2.90	100,000	59.4	0
	Lower	1/8	3.00	3.00	NA	9.23	NA
Vanadium (V)	Upper	9/9	6.70 - 21.4	11.8	1,400	94.3	0
	Lower	8/8	2.20 - 46.0	22.5	NA	155	NA
Zinc (Zn)	Upper	9/9	7.00 - 87.8	47.5	61,000	827	0
	Lower	8/8	2.10 - 52.2	23.9	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Four VOCs were detected in soil samples collected at AOC 583. Seven detections occurred in the upper interval and ten in the lower interval. No VOCs exceeded their respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-four SVOCs were detected in soil samples collected at AOC 583. Sixty-eight detections occurred in the upper interval and 45 in the lower interval. No SVOCs exceeded their respective industrial RBC in the upper interval. However, two SVOCs — benzo(a)anthracene and chrysene — exceeded their respective SSL in the lower interval.

Benzo(a)anthracene was detected in three of eight lower-interval samples with a range of 96 to 4,100 μg/kg and a mean of 1,450 μg/kg. One lower-interval sample (583SB007, 4,100 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Chrysene was detected in three of eight lower-interval samples with a range of 130 to 4,400 μg/kg and a mean of 1,580 μg/kg. One lower-interval sample (583SB007, 4,400 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 583. The upper-interval BEQ was calculated with detections in five samples, with a range of 101 to 469 μg/kg and a mean of 250 μg/kg. No upper-interval samples exceeded the BEQ industrial RBC of 780.0 μg/kg. The lower-interval BEQ was calculated with detections in three samples, with a range of 118 to 5,9900 μg/kg and a mean of 2,110 μg/kg. One lower-interval sampled (583SB007, 5,590 μg/kg) exceeded the BEQ SSL of 4,000 μg/kg.

Pesticides in Soil

One pesticide — 4,4'-DDE — was detected in soil samples collected at AOC 583. One detection occurred in the lower interval and zero in the upper interval. The pesticide did not exceed its respective SSL in the lower interval.

Other Organic Compounds in Soil

Four dioxins were detected in the upper-interval duplicate soil sample collected at AOC 583. No industrial RBCs have been established for the detected dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the upper-interval duplicate soil sample. The calculated TEQ of 0.309 ng/kg did not exceed the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

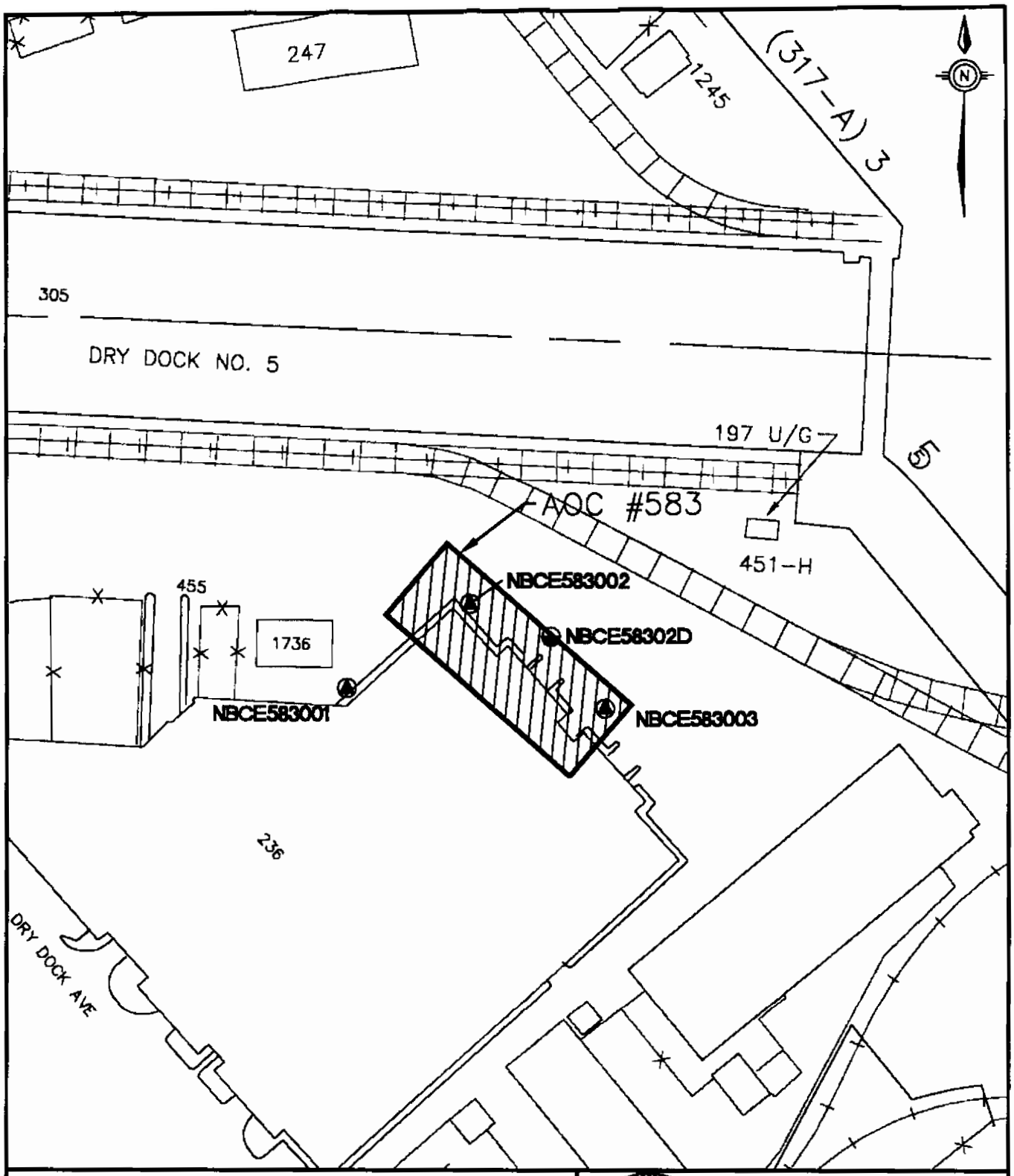
Twenty-four metals were detected in soil samples collected at AOC 583. One hundred and sixty-six detections occurred in the upper interval and 144 in the lower interval. No metal exceeded both its respective industrial RBC and background RC in the upper interval or respective SSL and background RC in the lower interval.

10.41.3 Groundwater Sampling and Analysis

One deep monitoring well and three shallow monitoring wells were installed and sampled to assess groundwater quality at AOC 583 as shown in Figure 10.41.2. The wells were installed as follows:

- Shallow Wells — NBCE583001, NBCE583002, NBCE583003
- Deep Wells — NBCE58302D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. No duplicate samples were collected at AOC 583. Table 10.41.3.1 summarizes groundwater sampling and analysis at AOC 583.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
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GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.41.2
MONITORING WELL LOCATIONS
AOC #583
BUILDING
236

DWG DATE: 09/02/97 | DWG NAME: 10-41-2

Table 10.41.3.1
AOC 583
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	3	3	VOCs, SVOCs, metals	VOCs, SVOCs, metals	None
Deep	1	1	VOCs, SVOCs, metals	VOCs, SVOCs, metals	None

The shallow monitoring wells were installed at 13.1 to 13.5 feet bgs in the surficial aquifer. The deep well was installed at 30.2 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.41.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow and deep groundwater are summarized in Tables 10.41.4.1 and 10.41.4.2, respectively. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.41.4.3 and 10.41.4.4. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.41.4.1
AOC 583
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Acetone	2/3	7.00 - 56.0	31.5	370	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.41.4.2
AOC 583
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Deep Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Acetone	1/1	10.0	10.0	370	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.41.4.3
AOC 583
Inorganics Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Calcium (Ca)	2/3	65,600 - 67,700	66,700	NA	NA	NA	NA
Cobalt (Co)	1/3	3.70	3.70	220	2.5	NA	0
Lead (Pb)	1/3	5.20	5.20	NA	4.8*	15.0	0
Magnesium (Mg)	3/3	4,800 - 30,000	14,000	NA	NA	NA	NA
Manganese (Mn)	3/3	8.90 - 49.4	32.2	84.0	2,560	NA	0
Potassium (K)	1/3	27,400	27,400	NA	NA	NA	NA
Sodium (Na)	3/3	66,800 - 129,000	101,000	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established
* = TTAL

Table 10.41.4.4
AOC 583
Inorganic Detections for First Quarter Groundwater (µg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/1	15.6	15.6	0.0450	16.4	50.0	0
Calcium (Ca)	1/1	93,400	93,400	NA	NA	NA	NA
Cobalt (Co)	1/1	2.20	2.20	220	12.9	NA	0
Magnesium (Mg)	1/1	45,600	45,600	NA	NA	NA	NA
Manganese (Mn)	1/1	417	417	84.0	869	NA	0
Nickel (Ni)	1/1	27.5	27.5	73.0	42.2	100	0
Potassium (K)	1/1	25,800	25,800	NA	NA	NA	NA
Sodium (Na)	1/1	614,000	614,000	NA	NA	NA	NA

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Volatile Organic Compounds in Groundwater

Shallow Groundwater

One VOC was detected in two of three shallow groundwater samples collected at AOC 583. The VOC did not exceed its respective tap-water RBC.

Deep Groundwater

One VOC was detected in the one deep groundwater sample collected at AOC 583. The VOC did not exceed its respective tap-water RBC.

Inorganic Elements in Groundwater

Shallow Groundwater

Seven metals were detected in shallow groundwater samples collected from AOC 583. None of the metals exceeded both their respective tap-water RBC and shallow groundwater RC.

Deep Groundwater

Eight metals were detected in the deep groundwater sample collected from AOC 583. None of the metals exceeded both their respective tap-water RBC and deep groundwater RC.

10.41.5 Fate and Transport Assessment for AOC 583

AOC 583 is comprised of the activities conducted in the northeast corner of Building 236, including a pipe-fitting shop area containing a Freon recycling and distillation unit, associated piping, and three USTs. Five additional USTs containing petroleum products are located outside the northeast corner of the building. The surrounding physical setting consists of Building 236, which is built on a concrete slab, and asphalt pavement outside the building. Environmental media sampled as part of the AOC 583 RFI include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for AOC 583 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.41.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.41.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background reference concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Six organic compounds — methylene chloride, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, n-nitroso-di-n-propylamine, and pentachlorophenol — were detected in AOC 583 soil at concentrations exceeding groundwater protection SSLs. Methylene chloride was detected at concentrations exceeding its generic SSL in two surface soil samples (583SB002 and 583SB006) and two subsurface soil samples (583SB005 and 583SB006). Benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected at a concentration exceeding their respective generic SSLs in the same subsurface soil sample (583SB007). N-nitroso-di-n-propylamine and pentachlorophenol were detected at concentrations exceeding their respective generic SSLs in the same surface soil sample (583SB006).

Two inorganics — antimony and chromium (total) — were detected at concentrations exceeding their respective groundwater protection SSLs. Antimony was detected at a concentration exceeding its generic SSL in one surface soil sample and one subsurface soil sample from the same soil boring (583SB008). Chromium was detected at a concentration exceeding its background reference value in one surface soil sample (583SB003). No constituent (organic or inorganic) exceeding generic SSLs and/or background reference values were detected in first-quarter groundwater samples at AOC 583, indicating that current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

10.41.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.41.5.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To

provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

More than 11 feet of clay and sandy clay overlie the surficial aquifer in deep well NBCE58302D, protecting the aquifer to some extent from contaminants migrating downward from surface soil. Boring logs from the three shallow wells show similar high clay content in subsurface soil and the upper portion of the saturated zone. No constituent (organic or inorganic) was detected in AOC 583 first-quarter groundwater samples above corresponding tap water RBCs, background reference values, or saltwater surface water chronic screening levels. As a result, the groundwater-to-surface water migration pathway is not expected to be a viable pathway at AOC 583.

10.41.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.41.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 583 is 70,200:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.41.5.4 Soil-to-Air Cross-Media Transport

Table 10.41.5.3 lists the VOCs detected in surface soil samples collected at AOC 583 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at AOC 583. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 583.

10.41.5.5 Fate and Transport Summary

In the first-tier screen, methylene chloride was detected at a concentration exceeding its generic groundwater protection SSL in two surface soil samples and two subsurface soil samples. Benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected at concentrations above their respective SSLs in a single subsurface soil sample. N-nitroso-di-n-propylamine and pentachlorophenol were detected at concentrations above their respective SSLs in a single surface soil sample. Antimony exceeded its generic SSL in one surface soil sample and one subsurface soil sample from the same soil boring. Chromium exceeded its background reference value in one surface soil sample.

No constituent exceeding first-tier screening values for soil were detected in first-quarter groundwater samples, nor did they exceed the adjusted screening values of the second-tier comparisons. This indicates that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.41.5.1
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 583
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	93	110	56	10	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	33	ND	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	28	37	ND	ND	10	4.1	2560	UG/KG	UG/L	YES	NO	NO
1,2,4-Trichlorobenzene	38	ND	ND	ND	2500	190	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	160	89	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	110	500	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	210	420	ND	ND	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	220	2600	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents	469	5990	ND	ND								
Benzo(a)anthracene	260	4100	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	300	3700	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	290	3300	ND	ND	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	310	3000	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	340	4400	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	95	1300	ND	ND	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	160	2200	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Carbazole	82	ND	ND	ND	300	3.4	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	59	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	ND	42	ND	ND	235000	29000	75.9	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	40	38	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	800	3400	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	71	180	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	51	ND	ND	690	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	58	ND	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
4-Nitrophenol	55	ND	ND	ND	14400	2300	71.7	UG/KG	UG/L	NO	NO	NO
N-Nitroso-di-n-propylamine	47	ND	ND	ND	0.025	0.0096	NA	UG/KG	UG/L	YES	NO	NO
Pentachlorophenol	59	ND	ND	ND	15	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	680	1700	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	740	6400	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
4,4'-DDE	ND	3.9	NA	NA	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.309	ND	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	14000	16200	ND	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	3.5	3.9	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	5.1	9.5	ND	15.6	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	33.2	41.9	ND	ND	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.44	0.76	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.17	ND	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	179	34.7	ND	ND	94.6	37000	103	MG/KG	UG/L	YES	NO	NO
Cobalt	3.8	4.4	3.7	2.2	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	22.8	14.3	ND	ND	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	39.8	41.9	5.2	ND	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	238	153	49.4	417	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.1	0.12	ND	ND	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	7.8	7.7	ND	27.5	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	1.2	ND	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	ND	0.39	ND	ND	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	ND	1	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	2.9	3	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO

Table 10.41.5.1
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 583
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Vanadium	21.4	46	ND	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	87.8	52.2	ND	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.41.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 583
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	Tap Water RBC Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
Methylene chloride	28	37	ND	ND	10	4.1	2560	4.1	2.88E+05	5	5.76E+04	5.76E+04	UG/KG	UG/L	NO	NO
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	260	4100	ND	ND	800	0.092	NA	0.092	6.46E+03	0.1	6.46E+04	5.17E+06	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	290	3300	ND	ND	2500	0.092	NA	0.092	6.46E+03	0.1	6.46E+04	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	95	1300	ND	ND	800	0.0092	NA	0.0092	6.46E+02	0.01	6.46E+04	5.17E+06	UG/KG	UG/L	NO	NO
N-Nitroso-di-n-propylamine	47	ND	ND	ND	0.025	0.0096	NA	0.0096	6.74E+02	0.01	6.74E+04	1.68E+02	UG/KG	UG/L	NO	NO
Pentachlorophenol	59	ND	ND	ND	15	0.56	7.9	0.56	3.93E+04	1	3.93E+04	5.90E+04	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	3.5	3.9	ND	ND	2.5	15	NA	15	1.05E+06	6	1.76E+05	4.39E+04	MG/KG	UG/L	NO	NO
Chromium (total)	179	34.7	ND	ND	19	180	50	50	3.51E+06	100	3.51E+04	6.67E+04	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 70,200: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.41.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 583
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	93	62000000	UG/KG	NO
Methylene chloride	28	7000	UG/KG	NO
1,2,4-Trichlorobenzene	38	240000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.41.6 Fixed-Point Risk Evaluation for AOC 583

10.41.6.1 Site Background and Investigative Approach

AOC 583 consists of the northeast corner of Building 236, where a shop contained a Freon recycling and distillation system as well as several USTs. In 1986, approximately 200 gallons of rinsate-containing paint stripper was discharged outside the northeast end of the building to the storm drain. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a Fixed-Point Risk Evaluation (FRE) following the framework presented in Section 7.3.

A total of nine surface soil samples were considered in the AOC 583 FRE. Four monitoring wells were installed as part of the 1995 RFI. Three of these monitoring wells were installed into the shallow aquifer and one was installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 583 FRE. Sections 10.41.1 and 10.41.3 contain summaries of the sampling effort for AOC 583 soil and groundwater.

10.41.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.41.6.1 provides CPSS summaries for AOC 583 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, BEQ equivalents, antimony, and chromium were identified as COPCs for AOC 583. Aluminum, arsenic, beryllium, and manganese were detected in AOC 583 soil at concentrations above their RBCs, but were eliminated from consideration in the residential FRE based on comparison to their background concentrations. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.41.6.2 summarizes the residential COPCs detected at each AOC 583 sample location with contribution to risk. As shown, BEQ equivalent compounds contribute to risk for AOC 583 surface soil, exceeding 1E-06 at five of nine locations. No COPCs were detected in samples 583SB001, 583SB002, 583SB004, and 583SB005 that would have contributed to risk estimates. Figure 10.41.3 is a spatial presentation of residential risk estimates for AOC 583 surface soil. For those samples with detected concentrations of BEQ equivalents, risk estimates range from 2E-06 to 8E-06 with an arithmetic mean risk of 2E-06 (assuming a deminimus risk of 1E-07 for samples with no detectable concentrations of BEQ equivalent compounds).

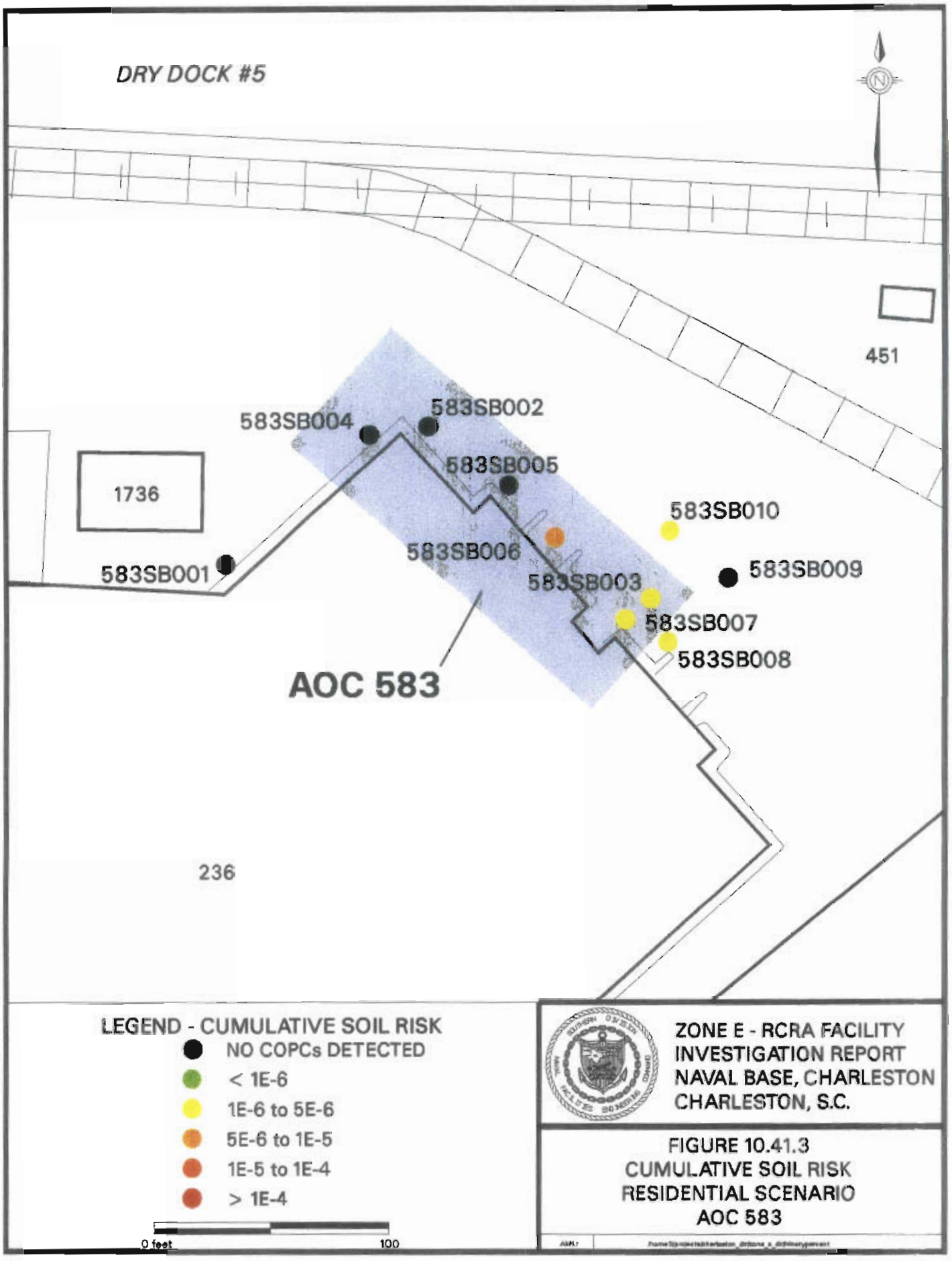
Antimony and chromium contribute to hazard estimates for AOC 583 surface soil, but they do not exceed unity at any of the nine sample locations. Hazard estimates range from 0.03 to 0.5 with an arithmetic mean hazard of 0.2.

Industrial Scenario

Based on industrial RBCs, no COPCs were identified for AOC 583 surface soil. Arsenic was detected in AOC 583 soil at concentrations above its industrial RBCs, but was eliminated from consideration in the residential FRE based on comparison to its background concentration. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

10.41.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.41.6.3 provides CPSS summaries for AOC 583 groundwater. No COPCs were identified in groundwater samples at AOC 583. The maximum concentrations of arsenic and manganese reported in the deep well exceeded their respective RBCs, but were eliminated from consideration in the deep groundwater FRE based on comparison to their corresponding background RCs. AOC 583 deep groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples). As a result, arsenic and manganese eliminated from


DRY DOCK #5
451
1736
583SB004
583SB002
583SB005
583SB010
583SB006
583SB001
583SB003
583SB009
583SB007
583SB008
AOC 583
236
LEGEND - CUMULATIVE SOIL RISK
NO COPCs DETECTED
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
100
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.41.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 583

the deep groundwater FRE based on direct comparison of their maximum concentration to their background RCs.

10.41.6.4 Uncertainty

AOC 583 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change. This area is located close to the quay wall and soil is likely sediment in what was formerly the river bank. Consequently, extensive filling would be required to redevelop this site as residences. Therefore chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at AOC 583, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is

unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 583. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBCs (e.g. within 10% of its RBCs).

Aluminum, arsenic, beryllium, and manganese were reported in AOC 583 soil at concentrations above their RBC benchmarks, but were eliminated from consideration in the FRE based on comparison to their corresponding background concentrations. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBCs (e.g. within 10% of its RBCs).

Arsenic and manganese were reported in AOC 583 deep groundwater at maximum concentrations above their respective RBC benchmarks, and were eliminated from consideration in the FRE based on comparison to their corresponding background concentrations. As a result, their contribution to hazard has not been considered in the deep groundwater FRE.

10.41.6.5 FRE Summary

The risk and hazard posed by contaminants at AOC 583 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers both the ingestion and inhalation pathways. Risk and HI estimates are presented on Table 10.41.6.2 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

BEQ equivalent compounds were detected in AOC 583 surface soil at concentrations above their residential risk-based RGOs in five of the nine samples. The calculated mean risk estimate was 2E-06 which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Antimony and chromium were detected in AOC 583 surface soil at concentrations that did not exceed residential hazard-based RGOs at any sample location. The calculated mean hazard estimate was 0.2, which is below USEPA's acceptable limit of unity.

Soil – Site Worker Scenario

No COPCs were identified for AOC 583 surface soil, based on industrial RBCs.

Groundwater – Residential Scenario

No COPCs were identified for AOC 583 groundwater, based on tap water RBCs.

Table 10.4.6.1
Chemicals Present in Site Samples
AOC 583 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Carcinogenic PAHs															
B(a)P Equiv.	*	5	9	101.298	468.94	250.4	831.96	878.18	88	780	NA	UG/KG	5		
Benzo(a)anthracene		5	9	75	260	162.4	360	380	880	7800	NA	UG/KG			
Benzo(b)fluoranthene		5	9	77	290	167.4	360	380	880	7800	NA	UG/KG			
Chrysene		5	9	98	340	215.6	360	380	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	3	9	40	95	61.0	360	380	88	780	NA	UG/KG	1		
Indeno(1,2,3-cd)pyrene		5	9	40	160	86.2	360	380	880	7800	NA	UG/KG			
Benzo(k)fluoranthene		5	9	94	310	176.8	360	380	8800	78000	NA	UG/KG			
Benzo(a)pyrene	*	5	9	81	300	170.2	360	380	88	780	NA	UG/KG	4		
TCDD Equivalents															
Dioxin Equiv.		1	1	0.3089	0.3089	0.3089	NA	NA	4.1	43	NA	NG/KG			
Inorganics															
Aluminum (Al)		9	9	3740	14000	6699	NA	NA	7800	100000	26600	MG/KG	2		
Antimony (Sb)	*	4	9	0.44	3.5	1.35	0.44	0.46	3.1	82	1.77	MG/KG	1		1
Arsenic (As)		9	9	0.76	5.1	3.27	NA	NA	0.43	3.8	23.9	MG/KG	9	3	
Barium (Ba)		9	9	14.2	33.2	21.19	NA	NA	550	14000	130	MG/KG			
Beryllium (Be)		9	9	0.15	0.44	0.29	NA	NA	0.15	1.3	1.7	MG/KG	9		
Cadmium (Cd)		3	9	0.11	0.17	0.13	0.11	0.44	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	9	9	6110	26400	16138	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)	*	9	9	9.8	179	56.2	NA	NA	39	1000	94.6	MG/KG	4		1
Cobalt (Co)		9	9	1	3.8	2.0	NA	NA	470	12000	19	MG/KG			
Copper (Cu)		9	9	2.2	22.8	14.2	NA	NA	310	8200	66	MG/KG			
Iron (Fe)	N	9	9	2230	12000	5794	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)		9	9	5	39.8	23.2	NA	NA	400	400	265	MG/KG			
Magnesium (Mg)	N	9	9	460	3130	1962	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)		9	9	22.1	238	94.7	NA	NA	180	4700	302	MG/KG	2		
Mercury (Hg)		7	9	0.02	0.1	0.061	0.02	0.04	2.3	61	2.6	MG/KG			
Nickel (Ni)		9	9	2.2	7.8	5.11	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N	9	9	236	1150	578.8	NA	NA	NA	NA	NA	MG/KG			
Sodium (Na)	N	7	9	158	353	262.7	199	245	NA	NA	NA	MG/KG			
Tin (Sn)		1	9	2.9	2.9	2.9	1.6	5.5	4700	6100	59.4	MG/KG			
Vanadium (V)		9	9	6.7	21.4	11.8	NA	NA	55	1400	94.3	MG/KG			

Table 10.41.6.1
Chemicals Present in Site Samples
AOC 583 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Vanadium (V)	9	9	6.7	21.4	11.8	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)	9	9	7	87.8	47.5	NA	NA	2300	61000	827	MG/KG			
Semivolatile Organics														
Acenaphthene	1	9	160	160	160.0	360	380	470000	12000000	NA	UG/KG			
Anthracene	2	9	79	110	94.5	360	380	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	5	9	46	220	109.6	360	380	310000	8200000	NA	UG/KG			
Benzoic acid	4	9	64	210	110.0	1700	1800	31000000	100000000	NA	UG/KG			
bis(2-Ethylhexyl)phthalate	1	9	40	40	40.0	360	380	46000	410000	NA	UG/KG			
Carbazole	1	1	82	82	82.0	NA	NA	32000	290000	NA	UG/KG			
Fluoranthene	6	9	56	800	312.7	360	380	310000	8200000	NA	UG/KG			
Fluorene	1	9	71	71	71.0	360	380	310000	8200000	NA	UG/KG			
Naphthalene	1	9	58	58	58.0	360	380	310000	8200000	NA	UG/KG			
4-Nitrophenol	1	9	55	55	55.0	1700	1800	480000	13000000	NA	UG/KG			
N-Nitroso-di-n-propylamine	1	9	47	47	47.0	360	380	91	820	NA	UG/KG			
Pentachlorophenol	1	9	59	59	59.0	1700	1800	5300	48000	NA	UG/KG			
Phenanthrene	5	9	65	680	269.8	360	380	310000	8200000	NA	UG/KG			
Pyrene	5	9	150	740	402.0	360	380	230000	6100000	NA	UG/KG			
Volatile Organics														
Acetone	2	8	82	93	87.5	11	11	780000	20000000	NA	UG/KG			
Methylene chloride	4	8	2	28	15.3	6	24	85000	760000	NA	UG/KG			
1,2,4-Trichlorobenzene	1	9	38	38	38.0	360	380	78000	2000000	NA	UG/KG			

Notes:
* - Identifed as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC -Risk based concentration
NA - Not applicable

Table 10.41.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 583
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
583	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
583	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
583	B001	Chromium (Cr)	39.80	MG/KG	0.1092	100.00	NA	
		Total			0.1092		NA	
583	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
583	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
583	B002	Chromium (Cr)	16.90	MG/KG	0.0463	100.00	NA	
		Total			0.0463		NA	
583	B003	Antimony (Sb)	1.00	MG/KG	0.0343	6.53	NA	
583	B003	B(a)P Equiv.	238.10	UG/KG	NA		3.9430	100.00
583	B003	Chromium (Cr)	179.00	MG/KG	0.4909	93.47	NA	
		Total			0.5252		3.9430	
583	B004	Antimony (Sb)	ND	MG/KG	NA		NA	
583	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
583	B004	Chromium (Cr)	22.50	MG/KG	0.0617	100.00	NA	
		Total			0.0617		NA	
583	B005	Antimony (Sb)	ND	MG/KG	NA		NA	
583	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
583	B005	Chromium (Cr)	9.80	MG/KG	0.0269	100.00	NA	
		Total			0.0269		NA	
583	B006	Antimony (Sb)	0.46	MG/KG	0.0158	18.88	NA	
583	B006	B(a)P Equiv.	468.94	UG/KG	NA		7.7658	100.00
583	B006	Chromium (Cr)	24.70	MG/KG	0.0677	81.12	NA	
		Total			0.0835		7.7658	
583	B007	Antimony (Sb)	ND	MG/KG	NA		NA	
583	B007	B(a)P Equiv.	156.16	UG/KG	NA		2.5861	100.00
583	B007	Chromium (Cr)	35.70	MG/KG	0.0979	100.00	NA	
		Total			0.0979		2.5861	
583	B008	Antimony (Sb)	3.50	MG/KG	0.1200	31.78	NA	
583	B008	B(a)P Equiv.	101.30	UG/KG	NA		1.6775	100.00
583	B008	Chromium (Cr)	93.90	MG/KG	0.2575	68.22	NA	
		Total			0.3775		1.6775	
583	B010	Antimony (Sb)	0.44	MG/KG	0.0151	6.16	NA	
583	B010	B(a)P Equiv.	287.42	UG/KG	NA		4.7598	100.00
583	B010	Chromium (Cr)	83.80	MG/KG	0.2298	93.84	NA	
		Total			0.2449		4.7598	

Table 10.41.6.3
Chemical Present in Site Samples
AOC 583 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Deep Wells													
Arsenic (As)		1	1	15.6	15.6	15.6	NA	NA	0.045	16.4	UG/L	1	
Calcium (Ca)	N	1	1	93400	93400	93400	NA	NA	NA	NA	UG/L		
Cobalt (Co)		1	1	2.2	2.2	2.2	NA	NA	220	12.9	UG/L		
Magnesium (Mg)	N	1	1	45600	45600	45600	NA	NA	NA	NA	UG/L		
Manganese (Mn)		1	1	417	417	417	NA	NA	84	869	UG/L	1	
Nickel (Ni)		1	1	27.5	27.5	27.5	NA	NA	73	42.2	UG/L		
Potassium (K)	N	1	1	25800	25800	25800	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	614000	614000	614000	NA	NA	NA	NA	UG/L		
Acetone		1	1	10	10	10	NA	NA	370	NA	UG/L		
Shallow Wells													
Calcium (Ca)	N	2	3	65600	67700	66650	22300	22300	NA	NA	UG/L		
Cobalt (Co)		1	3	3.7	3.7	3.7	2	2	220	2.5	UG/L		1
Lead (Pb)		1	3	5.2	5.2	5.2	3	3	15	4.8	UG/L		1
Magnesium (Mg)	N	3	3	4800	30000	13953	NA	NA	NA	NA	UG/L		
Manganese (Mn)		3	3	8.9	49.4	32.17	NA	NA	84	2560	UG/L		
Potassium (K)	N	1	3	27400	27400	27400	4810	5110	NA	NA	UG/L		
Sodium (Na)	N	3	3	66800	129000	101267	NA	NA	NA	NA	UG/L		
Acetone		2	3	7	56	31.5	10	10	370	NA	UG/L		

Notes:
* - Identified as a COPC
N - Essential Nutrient
UG/L - Micrograms per liter
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not Applicable

10.41.7 Corrective Measures Considerations

For AOC 583, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is paved with asphalt. All soil samples were collected from beneath the pavement.

BEQs was identified as a COC in the surface soil at AOC 583. The soil pathway residential exposure risk is 2E-06 and is between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk. Four of the nine soil samples collected contained no COPCs.

Residential risk-based remedial goal for surface soil set for BEQs is 0.06 mg/kg based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.41.7.1. Corrective measures for AOC 583 are detailed in Section 9.

No COPCs were identified in the shallow or deep groundwater for AOC 583.

Table 10.41.7.1
Potential Corrective Measures for AOC 583

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste

with detected concentrations of Aroclor-1260 and BEQ equivalents, risk estimates range from 6E-07 to 1E-05 with an arithmetic mean risk of 6E-06 (assuming a deminimus risk of 1E-07 for samples with no detectable concentrations of Aroclor-1260 or BEQ equivalent compounds).

Manganese is the sole contributor to hazard estimates for AOC 586 surface soil, but it does not exceed unity at any of the four sample locations. Hazard estimates range from 0.04 to 0.1 with an arithmetic mean hazard of 0.07.

Industrial Scenario

Table 10.42.6.3 summarizes the industrial COPCs detected at each AOC 586 sample location with contribution to risk. Based on industrial RBCs, Aroclor-1260 was identified as a COPC for AOC 586 surface soil, but it did not exceed 1E-06 at any of the four sample locations. Risk estimates in samples that contained detectable concentrations of Aroclor-1260 range from 1E-07 to 8E-07, with an arithmetic mean risk of 3E-07 (assuming a deminimus risk of 1E-07 for samples with no detectable concentrations of Aroclor-1260). Arsenic was detected in AOC 586 soil at concentrations above its industrial RBC, but was eliminated from consideration in the residential FRE based on comparison to its background concentration. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

No COPCs were identified for surface soil based on industrial RBCs that would have contributed to hazard estimates.

10.42.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.42.6.4 provides CPSS summaries for AOC 586 groundwater. No COPCs were identified in groundwater samples at AOC 586. The maximum concentration of arsenic reported in the shallow well exceeded its RBC, but was eliminated from consideration in the groundwater

FRE based on comparison to its background RC. AOC 586 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples). As a result, arsenic was eliminated from the shallow groundwater FRE based on direct comparison of its maximum concentration to its background RC.

10.42.6.4 Uncertainty

AOC 586 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at AOC 586, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously

mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 586. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBCs (e.g., within 10% of its RBCs).

Aluminum, arsenic, beryllium, and thallium were reported in AOC 586 soil at concentrations above their RBC benchmarks, but were eliminated from consideration in the FRE based on comparison to their corresponding background concentrations. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBCs (e.g., within 10% of its RBCs).

Arsenic was reported in AOC 586 groundwater at a maximum concentration above its RBC benchmark, and was eliminated from consideration in the FRE based on comparison to its background concentration. As a result, their contribution to hazard has not been considered in the groundwater FRE.

10.42.6.5 FRE Summary

The risk and hazard posed by contaminants at AOC 586 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.42.6.2 and 10.42.6.3, such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Aroclor-1260 and BEQ equivalent compounds were detected in AOC 586 surface soil at concentrations above their residential risk-based RGOs in two of four samples. The calculated mean risk estimate was 6E-06 which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Manganese was detected in AOC 586 surface soil at concentrations that did not exceed residential hazard-based RGOs at any sample location. The calculated mean hazard estimate was 0.07, which is below USEPA's acceptable limit of unity.

Soil — Site Worker Scenario

Aroclor-1260 was detected in AOC 586 surface soil at concentrations that did not exceed industrial risk-based RGOs at any sample location. The calculated mean risk estimate was 3E-07, which is below the 1E-06 SCDHEC risk level of concern, and USEPA's 1E-06 to 1E-07 acceptable risk range.

Groundwater — Residential Scenario

No COPCs were identified for AOC 586 groundwater, based on tap water RBCs.

Table 10.42.6.1
Chemicals Present in Site Samples
AOC 586 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
PCBs																
Aroclor-1260	*	*	3	4	110	870	373	94	94	83	740	NA	UG/KG	3	1	
Carcinogenic PAHs																
B(a)P Equiv.	*		3	4	0.14	641.36	347	2149.23	2149.23	88	780	NA	UG/KG	2		
Benzo(a)anthracene			2	4	170	380	275	930	940	880	7800	NA	UG/KG			
Benzo(b)fluoranthene			2	4	460	590	525	930	940	880	7800	NA	UG/KG			
Chrysene			3	4	140	460	303	930	930	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*		1	4	94	94	94	820	940	88	780	NA	UG/KG	1		
Indeno(1,2,3-cd)pyrene			2	4	240	260	250	930	940	880	7800	NA	UG/KG			
Benzo(k)fluoranthene			2	4	330	390	360	930	940	8800	78000	NA	UG/KG			
Benzo(a)pyrene	*		2	4	310	420	365	930	940	88	780	NA	UG/KG	2		
Inorganics																
Aluminum (Al)			4	4	6400	11700	7973	NA	NA	7800	100000	26600	MG/KG	1		
Antimony (Sb)			2	4	1.3	1.8	1.55	0.61	0.76	3.1	82	1.77	MG/KG			1
Arsenic (As)			4	4	7.9	23.3	14.6	NA	NA	0.43	3.8	23.9	MG/KG	4	4	
Barium (Ba)			4	4	22	35.8	28.9	NA	NA	550	14000	130	MG/KG			
Beryllium (Be)			4	4	0.63	0.96	0.75	NA	NA	0.15	1.3	1.7	MG/KG	4		
Cadmium (Cd)			3	4	0.34	0.8	0.5	0.19	0.19	3.9	100	1.5	MG/KG			
Calcium (Ca)	N		4	4	18100	85400	62225	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)			4	4	25.8	32.9	28.85	NA	NA	39	1000	94.6	MG/KG			
Cobalt (Co)			4	4	3.2	13.4	6.45	NA	NA	470	12000	19	MG/KG			
Copper (Cu)			4	4	16.5	104	46.2	NA	NA	310	8200	66	MG/KG			1
Iron (Fe)	N		4	4	8440	22500	12655	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)			4	4	19.1	132	61.9	NA	NA	400	1300	265	MG/KG			
Magnesium (Mg)	N		4	4	3790	4220	3948	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)	*		4	4	140	431	240.5	NA	NA	180	4700	302	MG/KG	3		1

Table 10.42.6.1
Chemicals Present in Site Samples
AOC 586 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Mercury (Hg)		4	4	0.06	0.3	0.17	NA	NA	2.3	61	2.6	MG/KG			
Nickel (Ni)		4	4	9.5	15.2	12.85	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N	4	4	1230	2430	1688	NA	NA	NA	NA	NA	MG/KG			
Selenium (Se)		4	4	1	1.2	1.1	NA	NA	39	1000	1.7	MG/KG			
Sodium (Na)	N	4	4	305	929	660	NA	NA	NA	NA	NA	MG/KG			
Thallium (Tl)		4	4	0.87	1.7	1.10	NA	NA	0.63	16	2.8	MG/KG	4		
Tin (Sn)		1	4	4.8	4.8	4.8	2.8	3.8	4700	6100	59.4	MG/KG			
Vanadium (V)		4	4	19.2	48.5	27.5	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)		4	4	73.6	178	114.6	NA	NA	2300	61000	827	MG/KG			
Semivolatile Organics															
Benzo(g,h,i)perylene		2	4	280	310	295	930	940	310000	8200000	NA	UG/KG			
Fluoranthene		2	4	170	600	385	930	940	310000	8200000	NA	UG/KG			
Phenanthrene		1	4	210	210	210	820	940	310000	8200000	NA	UG/KG			
Pyrene		3	4	170	660	360	930	930	230000	6100000	NA	UG/KG			
Volatile Organics															
2-Butanone (MEK)		1	4	4	4	4	12	35	4700000	100000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not Applicable

Table 10.42.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 586
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
586	001	Aroclor-1260	870.00	UG/KG	NA		3.9473	37.30
586	001	B(a)P Equiv.	400.61	UG/KG	NA		6.6342	62.70
586	001	Manganese (Mn)	202.00	MG/KG	0.0589	100.00	NA	
		Total			0.0589		10.5815	
586	002	Aroclor-1260	110.00	UG/KG	NA		0.4991	4.49
586	002	B(a)P Equiv.	641.36	UG/KG	NA		10.6211	95.51
586	002	Manganese (Mn)	431.00	MG/KG	0.1257	100.00	NA	
		Total			0.1257		11.1202	
586	003	Aroclor-1260	140.00	UG/KG	NA		0.6352	99.64
586	003	B(a)P Equiv.	0.14	UG/KG	NA		0.0023	0.36
586	003	Manganese (Mn)	140.00	MG/KG	0.0408	100.00	NA	
		Total			0.0408		0.6375	
586	004	Aroclor-1260	ND	UG/KG	NA		NA	
586	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
586	004	Manganese (Mn)	189.00	MG/KG	0.0551	100.00	NA	
		Total			0.0551		NA	

Table 10.42.6.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 586
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
586	B001	Aroclor-1260	870.00	UG/KG	NA		0.8026	100.00
		Total			NA		0.8026	
586	B002	Aroclor-1260	110.00	UG/KG	NA		0.1015	100.00
		Total			NA		0.1015	
586	B003	Aroclor-1260	140.00	UG/KG	NA		0.1292	100.00
		Total			NA		0.1292	
586	B004	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	

Table 10.42.6.4
Chemicals Present in Site Samples
AOC 586 - Shallow Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentratio	Range of SQL		creening Concentratio Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics												
Aluminum (Al)	1	1	157	157	157	NA	NA	3700	2810	UG/L		
Arsenic (As)	1	1	11.4	11.4	11.4	NA	NA	0.045	18.7	UG/L	1	
Semivolatile Organics												
Naphthalene	1	1	5	5	5	NA	NA	150	NA	UG/L		

Notes:
* - Identified as a COPC
UG/L - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

10.42.7 Corrective Measures Considerations

For AOC 586, the upper and lower soil intervals and the shallow groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is covered with gravel. One of four soil samples were collected from beneath the concrete.

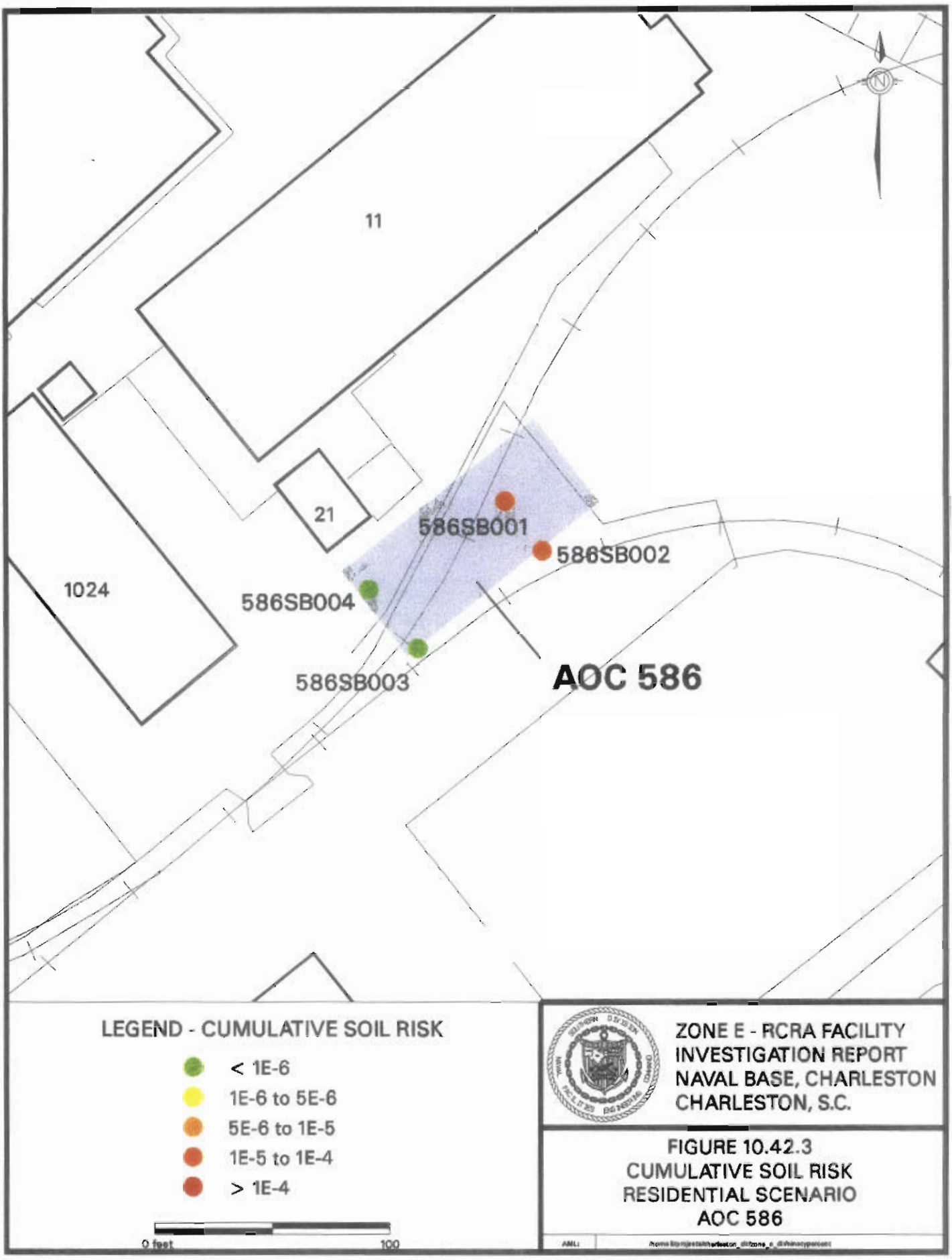
Aroclor-1260, BEQs, and manganese were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 6E-06 and the arithmetic mean HI is 0.07. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and below USEPA's lower acceptable HI range of 0.1. One sample had no COPCs.

Residential risk-based remedial goals for surface soil set for Aroclor-1260 and BEQs are 0.22 and 0.06 mg/kg, respectively, based on a target risk of 1E-06. The hazard-based remedial goal for surface soil set for manganese is 10,210 mg/kg based on a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.42.7.1. Corrective measures for AOC 586 are detailed in Section 9.

No COPCs were identified in the shallow groundwater for AOC 586.

Table 10.42.7.1
Potential Corrective Measures for AOC 586

Medium	Compounds	Potential Corrective Measures
Soil	Aroclor-1260, BEQs, and manganese	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste


11
21
1024
586SB001
586SB002
586SB004
586SB003
AOC 586
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
100
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.42.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 586

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10.43 AOC 590, Alley, Buildings 79 and 1760

AOC 590 is the alley between Buildings 1760 and 79. Reportedly, this alley is the site of past releases of acetone and cutting oil. No information was found regarding the exact locations, volumes, or duration of the discharged wastes. Currently, the alley is paved with asphalt.

Materials of concern identified in the *Final Zone E RFI Work Plan* include acetone and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

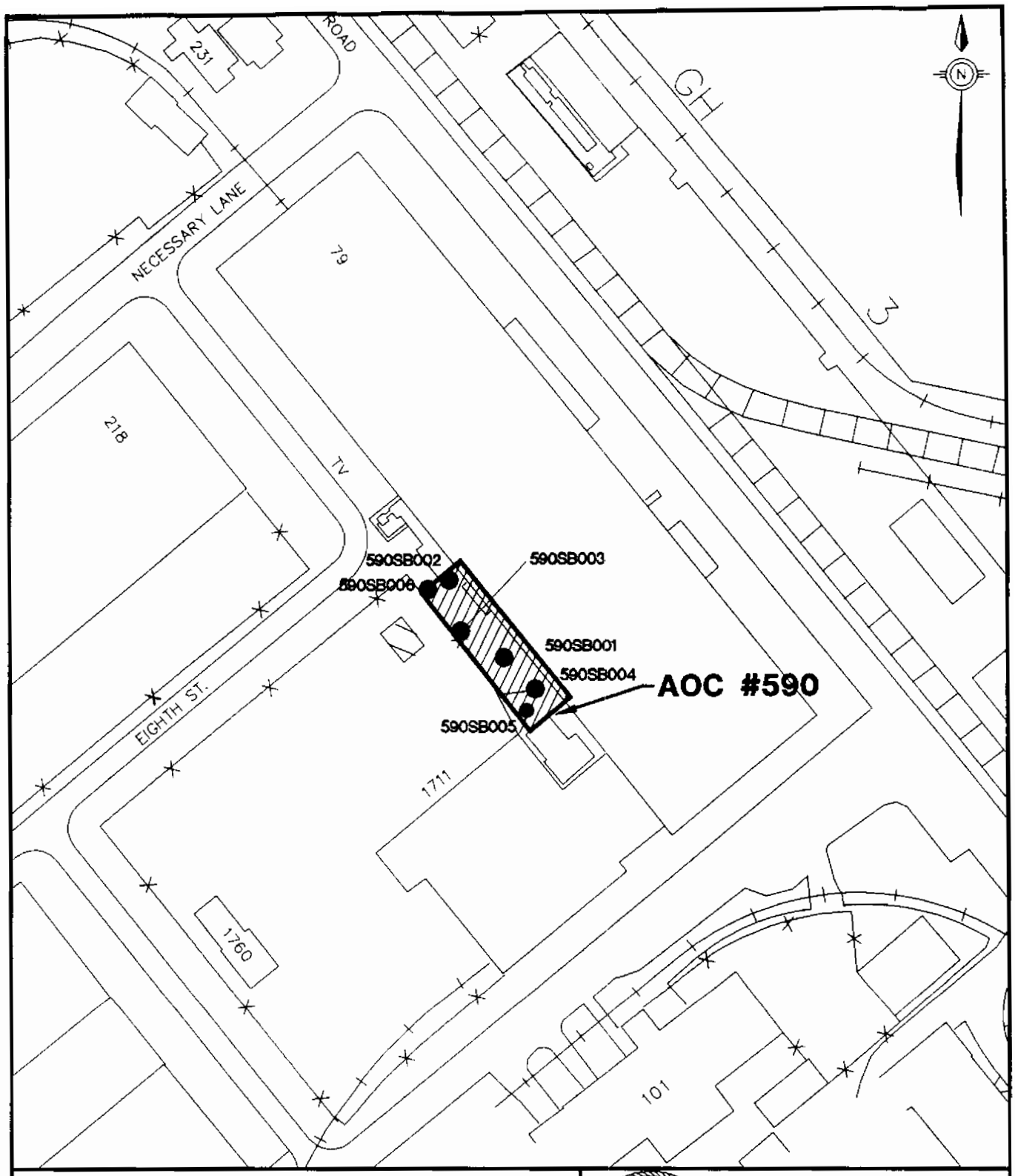
To fulfill the CSI objectives for AOC 590, soil, sediment, and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.43.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 590 from the locations shown in Figure 10.43.1. The *Final Zone E RFI Work Plan*, proposed collecting four soil samples from the upper interval and four samples from the lower interval. Soil samples were also collected at both intervals from the shallow monitoring well location proposed at this site.

First-round Sampling — During the first round of sampling, all five proposed upper- and lower-interval samples were collected.

First-round samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. In addition, five samples (1 upper-interval, 4 lower-interval) were submitted to be analyzed for TPH due to elevated OVA readings and petroleum odor in the sample. No duplicate samples were collected at AOC 590. Table 10.43.1.1 summarizes the first round of soil sampling at AOC 590.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.43.1
SOIL SAMPLE LOCATIONS
AOC #590
ALLEY BETWEEN
BUILDINGS 79 & 1760

DWG DATE: 09/02/97 | DWG NAME: 10-43-1

Table 10.43.1.1
AOC 590
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	5	5	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was submitted for TPH analysis
Lower	5	5	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	Four samples were submitted for TPH analysis

Second-round Sampling — Second-round sampling was performed at AOC 590 after first-round analytical results were compared to the USEPA Region III RBCs (April 1996). Parameters exceeding RBCs included SVOCs and metals. Section 10.43.2 details specific parameters and locations which exceeded RBCs.

Proposed second-round samples included one upper- and one lower-interval sample to determine the extent of constituents detected during first-round sampling. The lower-interval sample could not be collected due to subsurface obstructions such as wood or rocks.

The second-round sample was submitted for analysis of SVOCs and metals. No duplicate samples were collected during second-round sampling. Table 10.43.1.2 summarizes the second round of sampling at AOC 590.

Table 10.43.1.2
AOC 590
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	1	1	SVOCs and metals	SVOCs and metals	None
Lower	1	0	SVOCs and metals	None	Sample could not be collected due to subsurface obstructions

10.43.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.43.2.1. Inorganic analytical results for soil are summarized in Table 10.43.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.43.2.1
AOC 590
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	5/5	57.0 - 200	113	20,000,000	0
	Lower	5/5	27.0 - 440	152	NA	NA
2-Butanone (MEK)	Upper	4/5	8.00 - 15.0	11.3	100,000,000	0
	Lower	3/5	20.0 - 40.0	30.7	NA	NA
Carbon disulfide	Upper	2/5	1.000 - 2.00	1.50	20,000,000	0
Toluene	Upper	1/5	1.000	1.000	41,000,000	0
Xylene (Total)	Upper	2/5	2.00	2.00	100,000,000	0

Table 10.43.2.1
AOC 590
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Acenaphthene	Upper	4/6	63.0 - 950	368	12,000,000	0
	Lower	1/5	1400	1,400	NA	NA
Anthracene	Upper	4/6	120 - 870	420	61,000,000	0
Benzo(g,h,i)perylene	Upper	5/6	180 - 1,100	534	8,200,000	0
	Lower	2/5	380 - 1,200	790	NA	NA
Benzoic acid	Lower	2/5	150 - 170	160	NA	NA
bis(2-Ethylhexyl)phthalate	Upper	1/6	180	180	410,000	0
	Lower	2/5	170 - 350	260	NA	NA
Dibenzofuran	Upper	1/6	260	260	820,000	0
Di-n-butylphthalate	Upper	1/6	100	100	20,000,000	0
Fluoranthene	Upper	6/6	130 - 3,800	1,510	8,200,000	0
	Lower	2/5	220 - 620	420	NA	NA
Fluorene	Upper	3/6	92.0 - 490	264	8,200,000	0
2-Methylnaphthalene	Upper	1/6	120	120	8,200,000	0
Naphthalene	Upper	1/6	660	660	8,200,000	0
Phenanthrene	Upper	5/6	280 - 3,500	1,320	8,200,000	0
	Lower	1/5	180	180	NA	NA
Pyrene	Upper	6/6	130 - 2,600	1,280	6,100,000	0
	Lower	2/5	220 - 650	435	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	6/6	17.8 - 2,870	983	780	2
	Lower	2/5	53.5 - 68.2	60.8	NA	NA

Table 10.43.2.1
AOC 590
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents)						
Benzo(a)anthracene	Upper	5/6	340 - 1,800	804	7,800	0
	Lower	1/5	180	180	NA	NA
Benzo(b)fluoranthene	Upper	6/6	86.0 - 1,700	633	7,800	0
	Lower	1/5	150	150	NA	NA
Benzo(k)fluoranthene	Upper	5/6	220 - 1,400	596	78,000	0
Benzo(a)pyrene	Upper	5/6	300 - 1,800	764	780	2
Chrysene	Upper	5/6	430 - 1,700	908	780,000	0
	Lower	2/5	190 - 460	325	NA	NA
Dibenz(a,h)anthracene	Upper	4/6	55.0 - 600	242	780	0
Indeno(1,2,3-cd)pyrene	Upper	6/6	92.0 - 1,000	485	7,800	0
	Lower	2/5	350 - 530	440	NA	NA
TPH (mg/kg)						
Gasoline	Upper	1/1	6.30	6.30	NA	NA

Notes:
µg/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.43.2.2
AOC 590
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	6/6	4,490 - 15,500	9,630	100,000	26,600	0
	Lower	5/5	11,100 - 28,100	20,900	NA	41,100	NA

Table 10.43.2.2
AOC 590
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	6/6	4,490 - 15,500	9,630	100,000	26,600	0
	Lower	5/5	11,100 - 28,100	20,900	NA	41,100	NA
Antimony (Sb)	Upper	6/6	0.540 - 11.6	2.74	82.0	1.77	6
	Lower	4/5	1.20 - 1.40	1.30	NA	1.60	NA
Arsenic (As)	Upper	6/6	4.00 - 21.5	9.38	3.80	23.9	6
	Lower	5/5	13.2 - 22.0	17.0	NA	19.9	NA
Barium (Ba)	Upper	6/6	15.7 - 133	47.4	14,000	130	0
	Lower	5/5	21.7 - 53.7	39.2	NA	94.1	NA
Beryllium (Be)	Upper	6/6	0.220 - 0.830	0.462	1.30	1.70	0
	Lower	5/5	0.810 - 1.40	1.12	NA	2.71	NA
Cadmium (Cd)	Upper	6/6	0.150 - 0.900	0.483	100	1.50	0
	Lower	5/5	0.300 - 0.980	0.530	NA	0.960	NA
Calcium (Ca)	Upper	6/6	6,730 - 61,100	24,700	NA	NA	NA
	Lower	5/5	40,000 - 146,000	67,600	NA	NA	NA
Chromium (Cr)	Upper	6/6	17.1 - 91.2	52.2	1,000	94.6	0
	Lower	5/5	35.7 - 55.4	48.6	NA	75.2	NA
Cobalt (Co)	Upper	6/6	1.20 - 9.90	3.63	12,000	19.0	0
	Lower	5/5	4.30 - 9.10	7.02	NA	14.9	NA
Copper (Cu)	Upper	6/6	16.8 - 235	89.2	8,200	66.0	0
	Lower	5/5	29.9 - 52.9	39.2	NA	152	NA
Iron (Fe)	Upper	6/6	5,070 - 18,800	10,800	61,000	NA	0
	Lower	5/5	17,700 - 40,500	30,200	NA	NA	NA
Lead (Pb)	Upper	6/6	26.0 - 871	247	1,300	265	0
	Lower	5/5	17.2 - 159	74.8	NA	173	NA
Magnesium (Mg)	Upper	6/6	909 - 5,220	2,810	NA	NA	NA
	Lower	5/5	5,950 - 6,880	6,370	NA	NA	NA

Table 10.43.2.2
AOC 590
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Mercury (Hg)	Upper	6/6	0.270 - 9.90	2.22	61	2.60	0
	Lower	5/5	0.160 - 3.20	1.00	NA	1.59	NA
Nickel (Ni)	Upper	6/6	6.50 - 22.8	13.5	4,100	77.1	0
	Lower	5/5	18.4 - 19.9	19.3	NA	57.0	NA
Potassium (K)	Upper	6/6	513 - 1,720	895	NA	NA	NA
	Lower	5/5	1,940 - 3,470	2,850	NA	NA	NA
Selenium (Se)	Upper	3/6	0.550 - 1.60	1.08	1,000	1.70	0
	Lower	5/5	1.40 - 2.90	2.10	NA	2.40	NA
Sodium (Na)	Upper	6/6	83.9 - 472	215	NA	NA	NA
	Lower	5/5	455 - 1,630	1,180	NA	NA	NA
Tin (Sn)	Upper	1/6	6.00	6.00	100,000	59.4	0
Vanadium (V)	Upper	6/6	9.70 - 39.9	23.7	1,400	94.3	0
	Lower	5/5	46.2 - 73.3	62.9	NA	155	NA
Zinc (Zn)	Upper	6/6	67.4 - 429	204	61,000	827	0
	Lower	5/5	118 - 179	160	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Five VOCs were detected in soil samples collected at AOC 590. Fourteen detections occurred in the upper interval and eight in the lower interval. No VOCs exceeded their respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in soil samples collected at AOC 590. Seventy-four detections occurred in the upper interval and 18 in the lower interval. One SVOC — BEQ — exceeded its respective industrial RBC in the upper interval. However, no SVOC exceeded its respective SSL in the lower interval.

Benzo(a)pyrene was detected in five of six upper-interval samples with a range of 300 to 1,800 μg/kg and a mean of 764 μg/kg. Two upper-interval samples (590SB001, 1,800 μg/kg; 590SB002, 930 μg/kg) exceeded the Benzo(a)pyrene industrial RBC of 780 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 590. The upper-interval BEQ was calculated for six samples with a range of 17.8 to 2,870 μg/kg and a mean of 983 μg/kg. Two samples (590SB001, 2,870 μg/kg; 590SB002, 1,445 μg/kg) exceeded the BEQ industrial RBC of 780.0 μg/kg.

Other Organic Compounds in Soil

TPH-gasoline was detected in one upper-interval sample collected at AOC 590. No industrial RBC has been established for TPH-gasoline in soil.

No TPH diesel-range organics were detected in soil samples collected at AOC 590.

Inorganic Elements in Soil

Twenty-two metals were detected in soil samples collected at AOC 590. One hundred and twenty-four detections occurred in the upper interval and 104 in the lower interval. No metal exceeded both its respective industrial RBC and background RC in the upper interval. One metal — arsenic — exceeded both its respective SSL and background RC in the lower interval.

Arsenic was detected in five of five lower-interval samples with a range of 13.2 to 22 mg/kg and a mean of 17 mg/kg. Two lower-interval samples (590SB003, 21.4 mg/kg; 590SB005, 22 mg/kg) exceeded both the arsenic SSL of 15 mg/kg and the background RC of 19.9 mg/kg.

10.43.3 Groundwater Sampling and Analysis

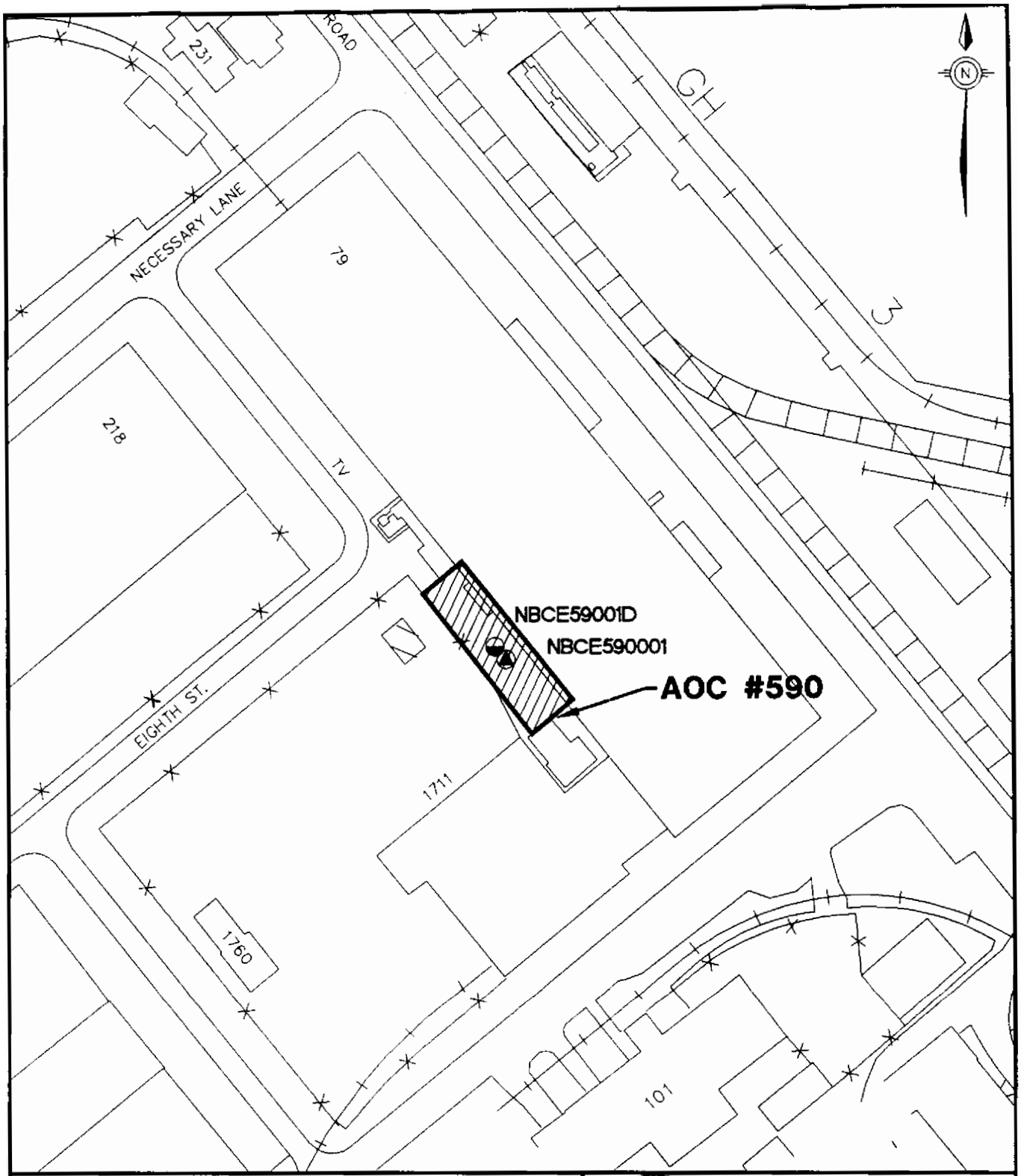
One shallow monitoring well and one deep monitoring well were installed and sampled to assess groundwater quality at AOC 590 as shown in Figure 10.43.2. The wells were installed as follows:

- Shallow Well — NBCE590001
- Deep Well — NBCE59001D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. No duplicate samples were collected at AOC 590. Table 10.43.3.1 summarizes groundwater sampling and analysis at AOC 590.

Table 10.43.3.1
AOC 590
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	VOCs, SVOCs, metals, chlorides, sulfates, TDS	VOCs, SVOCs, metals, chlorides, sulfates, TDS	None
Deep	1	1	VOCs, SVOCs, metals, chlorides, sulfates, TDS	VOCs, SVOCs, metals, chlorides, sulfates, TDS	None



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.43.2
MONITORING WELL LOCATIONS
AOC #590
ALLEY BETWEEN
BUILDINGS 79 & 1760

DWG DATE: 09/02/97 | DWG NAME: 10-43-2

The shallow monitoring well was installed at 12.5 feet bgs in the surficial aquifer. The deep monitoring well was installed at 30 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.43.4 Nature of Contamination in Groundwater

No organic compounds were detected in shallow groundwater. Organic compound analytical results for deep groundwater are summarized in Table 10.43.4.1. Inorganic analytical results for shallow and deep groundwater are summarized in Table 10.43.4.2 and 10.43.4.3. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.43.4.1
AOC 590
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Deep Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Acetone	1/1	16.0	16.0	370	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference concentration
NA = No MCL established

Table 10.43.4.2
AOC 590
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/1	19.9	19.9	0.045	18.7	50.0	1
Calcium (Ca)	1/1	97,300	97,300	NA	NA	NA	NA

Table 10.43.4.2
AOC 590
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Iron (Fe)	1/1	18,800	18,800	1,100	NA	NA	1
Magnesium (Mg)	1/1	49,500	49,500	NA	NA	NA	NA
Manganese (Mn)	1/1	730	730	84.0	2,560	NA	0
Potassium (K)	1/1	41,400	41,400	NA	NA	NA	NA
Sodium (Na)	1/1	537,000	537,000	NA	NA	NA	NA
Vanadium (V)	1/1	2.30	2.30	26.0	11.4	NA	0

Notes:
μg/L = micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, RC, or MCL established

Table 10.43.4.3
AOC 590
Inorganic Detections for First Quarter Groundwater (μg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Barium (Ba)	1/1	281	281	260	218	2,000	1
Beryllium (Be)	1/1	1.30	1.30	0.0160	1.2	4.00	1
Calcium (Ca)	1/1	224,000	224,000	NA	NA	NA	NA
Magnesium (Mg)	1/1	730,000	730,000	NA	NA	NA	NA
Manganese (Mn)	1/1	197	197	84.0	869	NA	0
Potassium (K)	1/1	282,000	282,000	NA	NA	NA	NA
Sodium (Na)	1/1	7,260,000	7,260,000	NA	NA	NA	NA

Table 10.43.4.3
AOC 590
Inorganic Detections for First Quarter Groundwater (μg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Vanadium (V)	1/1	3.30	3.30	26.0	5.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, RC, or MCL established

Volatile Organic Compounds in Groundwater

Deep Groundwater

One VOC was detected in the one deep groundwater sample collected at AOC 590. The VOC did not exceed its respective tap-water RBC.

Inorganic Elements in Groundwater

Shallow Groundwater

Eight metals were detected in the one shallow groundwater sample collected from AOC 590. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and background shallow groundwater RC (where available).

Arsenic was detected in well NBCE590001 (19.9 μg/L), exceeding both its tap-water RBC of 0.045 μg/L and shallow groundwater RC of 18.7 μg/L. The detection did not exceed the arsenic MCL of 50.0 μg/L.

Iron was detected in well NBCE590001 (18,800 μg/L), exceeding its tap-water RBC of 1,100 μg/L; no shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

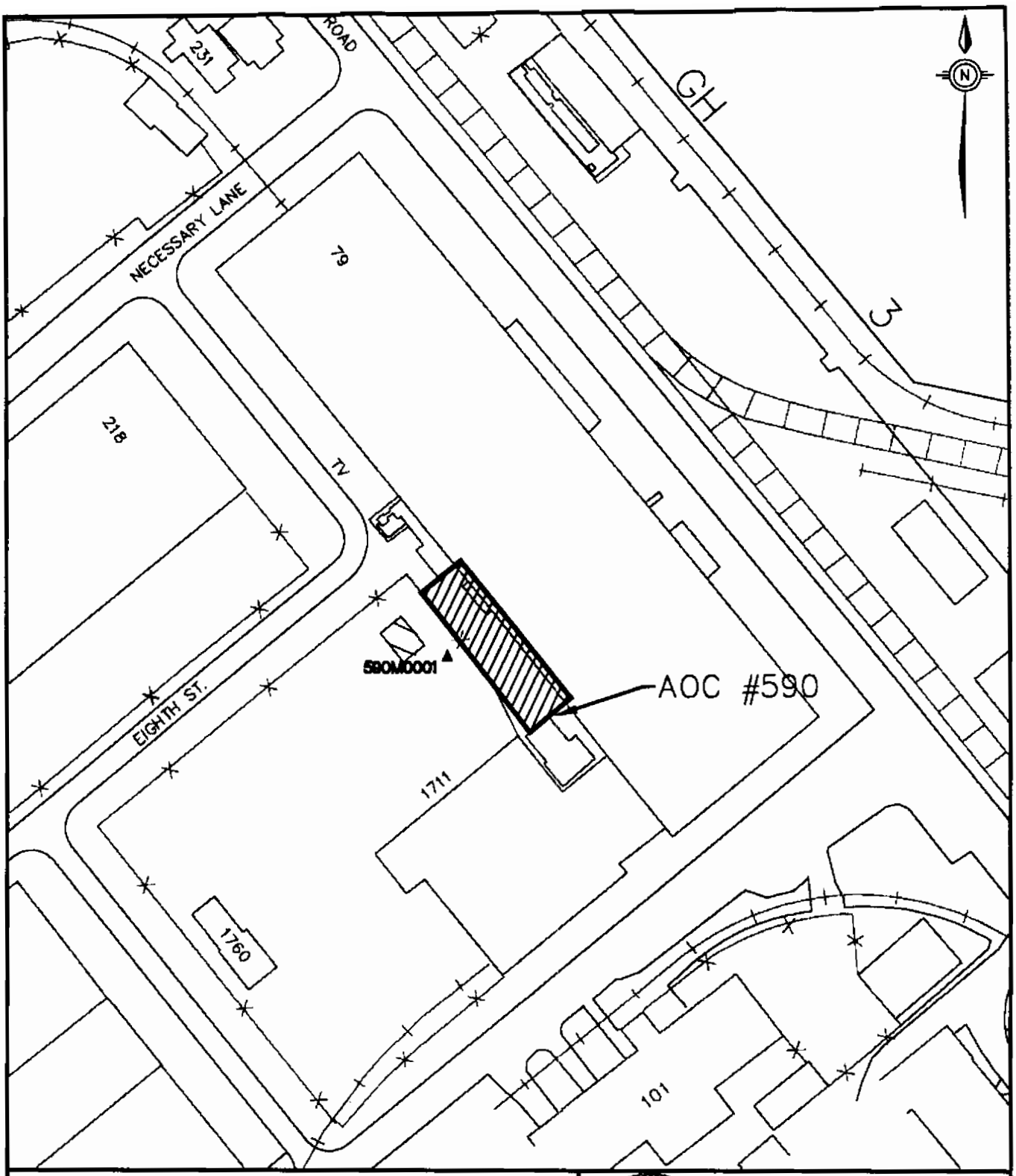
Eight metals were detected in the deep groundwater sample collected from AOC 583. Two metals — barium and beryllium — exceeded both their respective tap-water RBC and background deep groundwater RC.

Barium was detected in well NBCE59001D (281 μg/L), exceeding both its tap-water RBC of 260 μg/L and deep groundwater RC of 218 μg/L. The detection did not exceed the barium MCL of 2,000 μg/L.

Beryllium was detected in well NBCE59001D (1.30 μg/L), exceeding both its tap-water RBC of 0.0160 μg/L and deep groundwater RC of 1.2 μg/L. The detection did not exceed the beryllium MCL of 4.00 μg/L.

10.43.5 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting two sediment samples at AOC 590 from the locations shown in Figure 10.43.3. One sediment sample was collected and submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. One sediment sample was not collected because a storm drain did not exist at the originally proposed location. No samples were selected as duplicates at this site. Table 10.43.5.1 summarizes sediment sampling and analysis at AOC 590.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.43.3
SEDIMENT SAMPLE LOCATIONS
AOC #590
ALLEY BETWEEN
BUILDINGS 79 & 1760

DWG DATE: 09/02/97 | DWG NAME: 10-43-3

Table 10.43.5.1
AOC 590
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
2	1	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was not collected

10.43.6 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.43.6.1. Inorganic analytical results for sediment are summarized in Table 10.43.6.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.43.6.1
AOC 590
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	1/1	460	460	20,000,000	0
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	1/1	147,000	147,000	780	1
Benzo(a)anthracene	Upper	1/1	120,000	120,000	7,800	1
Benzo(b)fluoranthene	Upper	1/1	110,000	110,000	7,800	1
Benzo(k)fluoranthene	Upper	1/1	57,000	57,000	78,000	0
Benzo(a)pyrene	Upper	1/1	92,000	92,000	780	1
Chrysene	Upper	1/1	110,000	110,000	780,000	0
Dibenz(a,h)anthracene	Upper	1/1	23,000	23,000	780	1
Indeno(1,2,3-cd)pyrene	Upper	1/1	85,000	85,000	7,800	1

Table 10.43.6.1
AOC 590
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
SVOCs						
Acenaphthene	Upper	1/1	38,000	38,000	12,000,000	0
Anthracene	Upper	1/1	48,000	48,000	61,000,000	0
Benzo(g,h,i)perylene	Upper	1/1	62,000	62,000	8,200,000	0
bis(2-Ethylhexyl)phthalate	Upper	1/1	8,900	8,900	410,000	0
Dibenzofuran	Upper	1/1	16,000	16,000	820,000	0
Fluoranthene	Upper	1/1	230,000	230,000	8,200,000	0
Fluorene	Upper	1/1	28,000	28,000	8,200,000	0
2-Methylnaphthalene	Upper	1/1	6,200	6,200	8,200,000	0
Naphthalene	Upper	1/1	17,000	17,000	8,200,000	0
Phenanthrene	Upper	1/1	190,000	190,000	8,200,000	0
Pyrene	Upper	1/1	190,000	190,000	6,100,000	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial soil RC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Table 10.43.6.2
AOC 590
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Aluminum (Al)	Upper	1/1	2,430	2,430	100,000	0
Antimony (Sb)	Upper	1/1	0.740	0.740	82	0
Arsenic (As)	Upper	1/1	3.00	3.00	3.8	0

Table 10.43.6.2
AOC 590
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Barium (Ba)	Upper	1/1	32.2	32.2	14,000	0
Beryllium (Be)	Upper	1/1	0.380	0.380	1.3	0
Cadmium (Cd)	Upper	1/1	2.20	2.20	100	0
Calcium (Ca)	Upper	1/1	19,700	19,700	NA	NA
Chromium (Cr)	Upper	1/1	32.4	32.4	1,000	0
Cobalt (Co)	Upper	1/1	2.40	2.40	12,000	0
Copper (Cu)	Upper	1/1	148	148	8,200	0
Iron (Fe)	Upper	1/1	8,990	8,990	NA	NA
Lead (Pb)	Upper	1/1	107	107	1,300	0
Magnesium (Mg)	Upper	1/1	1,100	1,100	NA	NA
Manganese (Mn)	Upper	1/1	126	126	4,700	0
Mercury (Hg)	Upper	1/1	0.0400	0.0400	61	0
Nickel (Ni)	Upper	1/1	20.1	20.1	4,100	0
Potassium (K)	Upper	1/1	641	641	NA	NA
Sodium (Na)	Upper	1/1	81.3	81.3	NA	NA
Vanadium (V)	Upper	1/1	9.30	9.30	1,400	0
Zinc (Zn)	Upper	1/1	538	538	61,000	0

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Volatile Organic Compounds in Sediment

One VOC — acetone — was detected in the sediment sample collected at AOC 590. The detected concentration did not exceed the arsenic industrial soil RBC. Acetone is also considered a common laboratory artifact or contaminant by the National Functional Guidelines, February 1994.

Semivolatile Organic Compounds in Sediment

Eighteen SVOCs were detected in the sediment sample collected at AOC 590. Five SVOCs — benzo(a)anthracene, benzo(b)fluoranthene, Benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene — exceeded their respective industrial soil RBCs.

Benzo(a)anthracene was detected in sediment sample 590M0001 at 120,000 μg/kg, exceeding the benzo(a)anthracene industrial soil RBC of 7,800 μg/kg.

Benzo(b)fluoranthene was detected in sediment sample 590M0001 at 110,000 μg/kg, exceeding the benzo(b)fluoranthene industrial soil RBC of 7,800 μg/kg.

Benzo(a)pyrene was detected in sediment sample 590M0001 at 92,000 μg/kg, exceeding the Benzo(a)pyrene industrial soil RBC of 780 μg/kg.

Dibenz(a,h)anthracene was detected in sediment sample 590M0001 at 23,000 μg/kg, exceeding the dibenz(a,h)anthracene industrial soil RBC of 780 μg/kg.

Indeno(1,2,3-cd)pyrene was detected in sediment sample 590M0001 at 85,000 μg/kg, exceeding the indeno(1,2,3-cd)pyrene industrial soil RBC of 7,800 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 590. The BEQ was calculated for sediment sample 590M0001 at 147,000 μg/kg, exceeding the BEQ industrial RBC of 780 μg/kg.

Inorganic Elements in Sediment

Twenty metals were detected in the sediment sample collected at AOC 590. None of the metals exceeded their respective industrial soil RBCs.

10.43.7 Fate and Transport Assessment for AOC 590

AOC 590 is the alley behind Building 79, reportedly the site of releases of acetone and cutting oil. The alley is paved with asphalt and includes two storm sewer inlets. Environmental media sampled as part of the AOC 590 RFI include surface soil, subsurface soil, catch-basin sediment, and shallow and deep groundwater. Potential constituent migration pathways investigated for AOC 590 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of volatiles from surface soil to air.

10.43.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.43.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background reference concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Benzo(a)anthracene was the only organic compound detected in AOC 590 soil at a concentration exceeding its first-tier groundwater protection SSL. It was detected in two surface soil samples (590SB001 and 590SB002) but not in first-quarter groundwater samples.

Six inorganics — antimony, copper, lead, manganese, mercury, and selenium — were detected in AOC 590 soil at concentrations exceeding their generic SSLs and/or background reference values. Antimony and copper were detected at concentrations exceeding their generic SSL and background reference value, respectively, in the same surface soil sample (590SB002). Lead was detected at a concentration exceeding its de facto SSL in one surface soil sample (590SB006). Manganese, mercury, and selenium were detected at concentrations exceeding their respective generic SSLs and/or background reference values in the same subsurface soil sample (590SB004); mercury also exceeded its background reference value in the surface soil sample from the same soil boring. Manganese was the only constituent (organic or inorganic) exceeding first-tier soil screening values that was also detected in first-quarter groundwater samples. Its detected concentrations in shallow and deep samples did not exceed first-tier groundwater screening levels, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

10.43.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.43.7.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Acetone was the only organic compound detected in first-quarter groundwater samples at AOC 590. Its detected concentration in the sample from deep well NBCE59001D did not exceed its tap water RBC or saltwater surface water chronic screening level. Two inorganics — arsenic and beryllium — were detected in AOC 590 first-quarter groundwater samples at concentrations

marginally exceeding their respective background reference values for groundwater. Arsenic exceeded its background value in the sample from the shallow well and beryllium in the sample from the deep well. Nevertheless, the maximum detected concentrations of arsenic and beryllium in first-quarter groundwater samples were still below their respective MCLs. No constituent (organic or inorganic) exceeded its saltwater surface water chronic screening levels.

10.43.7.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.43.7.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 590 is 101,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.43.7.4 Surface Soil-to-Sediment Cross-Media Transport

One sediment sample was collected from a catch basin at AOC 590. Tables 10.43.6.1 and 10.43.6.2 summarize the organic and inorganic constituent concentrations detected in sediment samples at AOC 590. All of the constituents detected in sediment samples were also detected in

surface soil samples at the site, including many PAHs and inorganics. This relationship implies either that surface soil is a potential source of these constituents in sediment, which is unlikely since the entire area is paved, or that both surface soil and sediment were contaminated by the same site sources. SVOCs were detected in the sediment sample at higher concentrations than in soil samples, inorganics at generally lower concentrations. Fate and transport for constituents detected in catch-basin sediment samples will be discussed in the Zone L RFI report.

10.43.7.5 Soil-to-Air Cross-Media Transport

Table 10.43.7.3 lists the VOCs detected in surface soil samples collected at AOC 590 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at AOC 590. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 590.

10.43.7.6 Fate and Transport Summary

In the first-tier screen, benzo(a)anthracene was detected at concentrations exceeding its generic groundwater protection SSL in two surface soil samples. Antimony, copper, lead, and mercury were detected at concentrations exceeding their respective generic groundwater SSLs and/or background reference values in one surface soil sample each. Manganese, mercury, and selenium were detected at concentrations exceeding their generic groundwater SSLs and/or background reference values in the same subsurface soil sample. No constituent (organic or inorganic) that exceeded its generic groundwater protection SSLs and/or background reference values for soil were detected in first-quarter groundwater samples at concentrations exceeding tap water RBCs, background reference values, or saltwater surface water chronic screening levels.

Arsenic was detected at a concentration exceeding its background reference value in one first-quarter shallow groundwater sample and beryllium in one deep groundwater sample; however,

maximum concentrations of both arsenic and beryllium in groundwater were below their respective MCLs.

No constituent exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.43.7.1
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 590
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *						Ground-Water Migration Concern	Surface Water Migration Concern
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential		
Volatile Organic Compounds												
Acetone	200	440	ND	16	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	15	40	ND	ND	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	2	ND	ND	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Toluene	1	ND	ND	ND	6000	750	37	UG/KG	UG/L	NO	NO	NO
Xylene (total)	2	ND	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	950	1400	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	870	ND	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	ND	170	ND	ND	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	1100	1200	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	1800	180	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	1800	ND	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	1700	150	ND	ND	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	1400	ND	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	1700	460	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	600	ND	ND	ND	800	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	1000	530	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	260	ND	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	100	ND	ND	ND	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	180	350	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	3800	620	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	490	ND	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	120	ND	ND	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	660	ND	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	3500	180	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	2600	650	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
TPH - Gasoline Range Organics												
Gasoline	6.3	ND	NA	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	15500	28100	ND	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	11.6	1.4	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	21.5	22	19.9	ND	23.9	18.7	36	MG/KG	UG/L	NO	YES	NO
Barium	133	53.7	ND	281	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.83	1.4	ND	1.3	32	1.2	NA	MG/KG	UG/L	NO	YES	NO
Cadmium	0.9	0.98	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	91.2	55.4	ND	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	9.9	9.1	ND	ND	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	235	52.9	ND	ND	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Lead	871	159	ND	ND	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	239	2160	730	197	881	2560	NA	MG/KG	UG/L	YES	NO	NO
Mercury	9.9	3.2	ND	ND	2.6	11	0.2	MG/KG	UG/L	YES	NO	NO
Nickel	22.8	19.9	ND	ND	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	1.6	2.9	ND	ND	2.5	180	71	MG/KG	UG/L	YES	NO	NO
Tin	6	ND	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	39.9	73.3	2.3	3.3	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	429	179	ND	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.43.7.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 590
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	1800	180	ND	ND	800	0.092	NA	0.092	9.29E+03	0.1	9.29E+04	7.43E+06	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	11.6	1.4	ND	ND	2.5	15	NA	15	1.52E+06	6	2.53E+05	6.31E+04	MG/KG	UG/L	NO	NO
Arsenic	21.5	22	19.9	ND	14.6	0.045	36	0.045	4.55E+03	50	9.09E+01	1.33E+02	MG/KG	UG/L	NO	NO
Beryllium	0.83	1.4	ND	1.3	32	0.016	NA	0.016	1.62E+03	4	4.04E+02	1.29E+03	MG/KG	UG/L	NO	NO
Copper	235	52.9	ND	ND	458	1500	2.9	2.9	2.93E+05	1300	2.25E+02	1.03E+04	MG/KG	UG/L	NO	NO
Lead	871	159	ND	ND	400	15	8.5	8.5	8.59E+05	15	5.72E+04	1.00E+06	MG/KG	UG/L	NO	NO
Manganese	239	2160	730	197	548	840	NA	840	8.48E+07	840	1.01E+05	1.00E+06	MG/KG	UG/L	NO	NO
Mercury	9.9	3.2	ND	ND	1.04	11	0.2	0.2	2.02E+04	2	1.01E+04	1.05E+03	MG/KG	UG/L	NO	NO
Selenium	1.6	2.9	ND	ND	2.5	180	71	71	7.17E+06	50	1.43E+05	3.59E+04	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 101,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.43.7.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 590
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	200	62000000	UG/KG	NO
2-Butanone (MEK)	15	10000	UG/KG	NO
Carbon Disulfide	2	11000	UG/KG	NO
Toluene	1	520000	UG/KG	NO
Xylene (total)	2	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.43.8 Fixed-Point Risk Evaluation for AOC 590

10.43.8.1 Site Background and Investigative Approach

AOC 590, located in the alley between Buildings 79 and 1760, is the site of a reported spill of acetone and cutting oil. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of six surface soil samples were considered in the AOC 590 FRE. Two monitoring wells were installed as part of the 1995 CSI. One of these monitoring wells was installed into the shallow aquifer and one was installed into the deep aquifer. Groundwater data generated from the first quarter CSI sampling event are used to represent point risk/hazard for the AOC 590 FRE. Sections 10.43.1 and 10.43.3 contain summaries of the sampling effort for AOC 590 soil and groundwater.

10.43.8.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.43.8.1 provides CPSS summaries for AOC 590 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, BEQ equivalents, antimony, chromium, lead, and mercury are identified as COPCs for AOC 590. Aluminum, arsenic, beryllium, and manganese were detected in AOC 590 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE based on comparison to their background concentrations. Chromium was also detected in AOC 590 surface soil at a concentration above its RBC but below its background concentration; however, Wilcoxon rank sum test analyses indicated that chromium should be included.

Chromium, which predominantly exists in either the trivalent or hexavalent state, was identified as a COPC based on a conservative comparison of the maximum concentration (regardless of

valence state) to the RBC for its hexavalent species (39 mg/kg). The RBC for trivalent chromium is 7,800 mg/kg and was not exceeded by reported surface soil concentrations. Since hexavalent chromium was not analyzed for at AOC 590, there is no basis for characterization of chromium valance state distribution. As a conservative measure, chromium was retained as a COPC, and all surface soil chromium was assumed to exist in the hexavalent state.

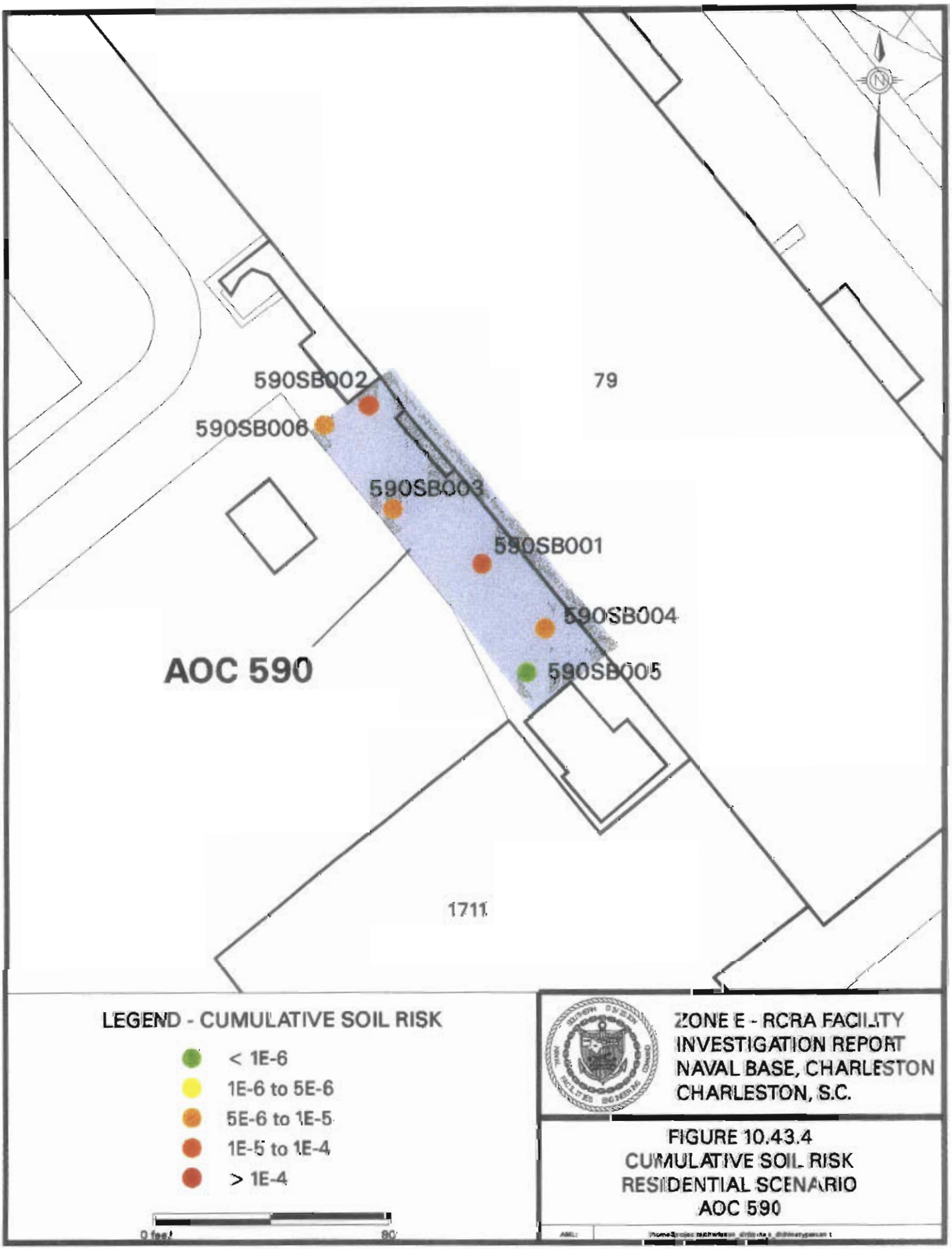
Table 10.43.8.2 summarizes the residential COPCs detected at each AOC 590 sample location with contribution to risk and hazard. As shown, BEQ equivalent compounds contribute to risk for AOC 590 surface soil, exceeding 1E-06 at five of six locations. Figure 10.43.4 is a spatial presentation of residential risk estimates for AOC 590 surface soil. Risk estimates range from 3E-07 to 5E-05 with an arithmetic mean risk of 2E-05.

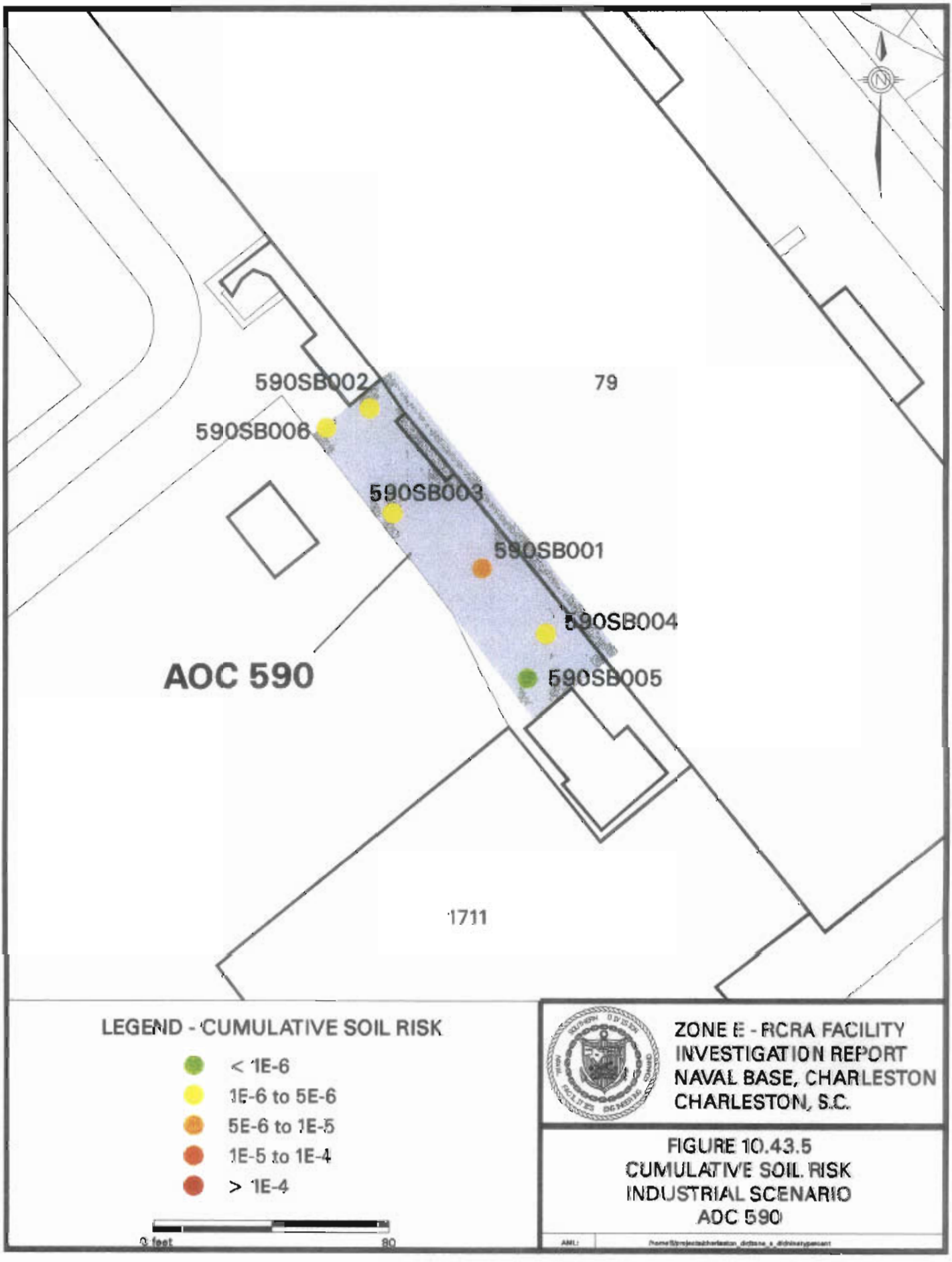
Antimony, chromium, and mercury contributed to hazard for AOC 590 surface soil, but did not exceed unity at any of the six sample locations. Hazard estimates range from 0.08 to 0.6, with an arithmetic mean hazard of 0.3.

Industrial Scenario

Based on industrial RBCs, BEQ equivalent compounds were identified as COPCs for AOC 590 surface soil. Arsenic was detected in AOC 590 soil at concentrations above its RBC, but was eliminated from consideration in the industrial FRE based on comparison to its background concentration. Table 10.43.8.3 summarizes the industrial COPCs detected at each AOC 590 location with contribution to risk. As shown, BEQ equivalent compounds contribute to risk for AOC 590 surface soil, exceeding 1E-06 at five of six locations. Figure 10.43.5 is a spatial presentation of industrial risk estimates for AOC 590 surface soil. Risk estimates range from 6E-08 to 1E-05, with an arithmetic mean risk of 3E-06.

No COPCs were identified for the industrial scenario that would have contributed to HI.


590SB002
590SB006
590SB003
590SB001
590SB004
590SB005
AOC 590
79
1711
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
80'
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.43.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 590


590SB002
590SB006
590SB003
590SB001
590SB004
590SB005
AOC 590
79
1711
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
80
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.43.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 590

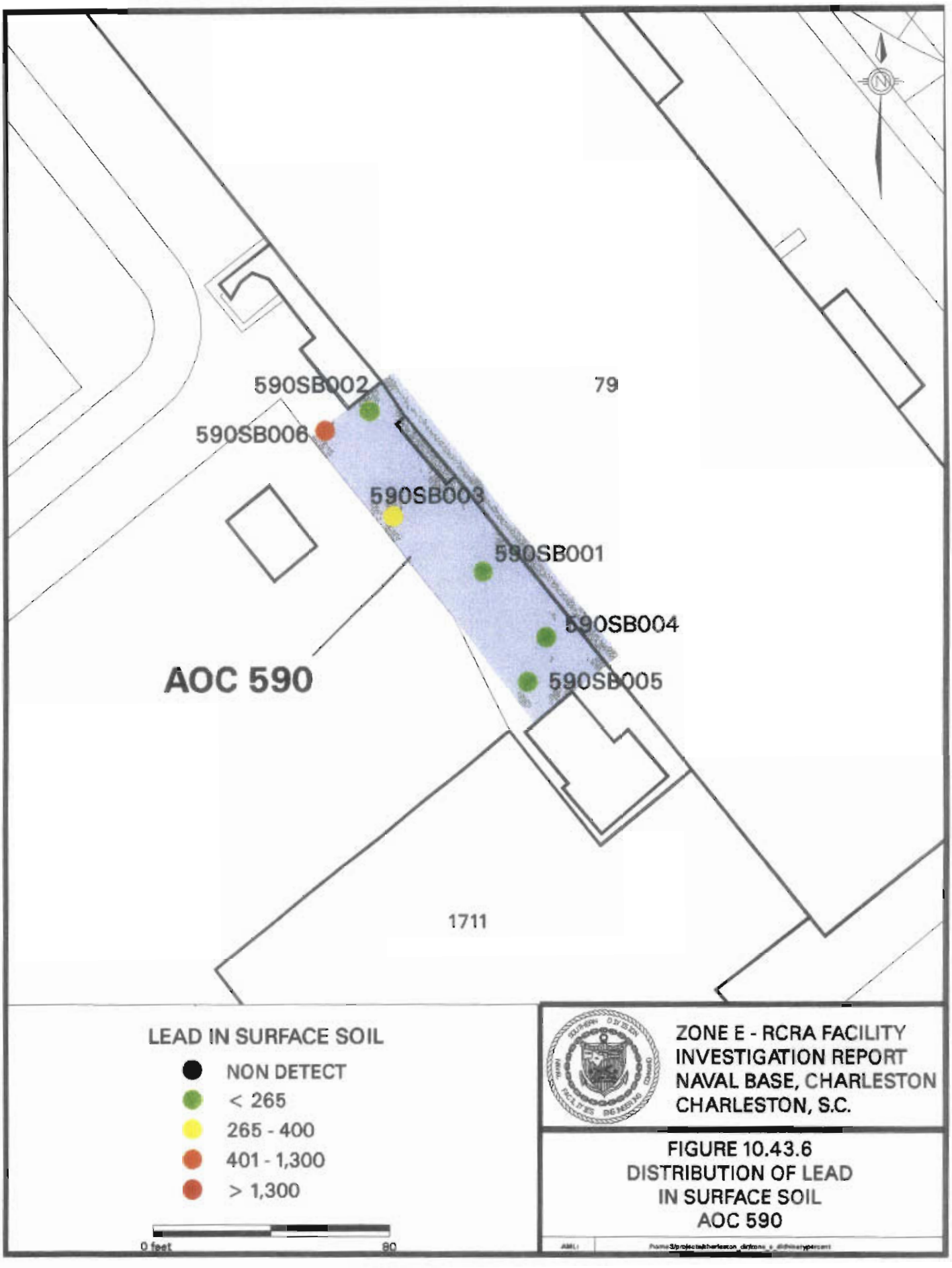
Lead

Lead was detected in all six surface soil samples collected at AOC 590. Soil concentrations ranged from 26 to 871 mg/kg and exceeded the residential clean up level of 400 mg/kg in only one of six samples. The mean detected lead concentration for AOC 590 is 247 mg/kg, representing an area of less than one-tenth of an acre. The mean concentration does not exceed the action level of 400 mg/kg, considered protective of children under a residential scenario, nor the industrial cleanup level of 1,300 mg/kg, considered protective of adults under an industrial scenario. Figure 10.43.6 is a spatial presentation of lead soil concentrations, using the surface soil background concentration of 265 mg/kg, the residential soil lead cleanup level of 400 mg/kg, and the industrial soil lead cleanup concentration of 1,300 mg/kg as benchmark levels to illustrate the lead soil concentrations for AOC 590.

10.43.8.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.43.8.4 provides CPSS summaries for AOC 590 groundwater and identifies COPCs. Barium and beryllium were identified as groundwater COPCs in the deep aquifer. Arsenic was identified as a groundwater COPC in the shallow aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. The maximum concentrations of manganese reported in both the deep and shallow well samples exceeded their RBCs, but were eliminated from consideration in the groundwater FRE based on comparison to their background RCs. AOC 590 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples each for both shallow and deep). As a result, manganese was eliminated from the groundwater FRE based on direct comparison of its maximum concentration to its background RC.

Table 10.43.8.5 summarizes the COPCs identified in AOC 590 monitoring wells sampled during the first quarter. The risk estimate for the deep aquifer was 8E-05, associated with a beryllium


590SB002
590SB006
590SB003
590SB001
590SB004
590SB005
AOC 590
79
1711
LEAD IN SURFACE SOIL
NON DETECT
< 265
265 - 400
401 - 1,300
> 1,300
0 feet
80
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.43.6
DISTRIBUTION OF LEAD
IN SURFACE SOIL
AOC 590

concentration of 1.3 μg/L in the deep aquifer (590G01D). Barium and beryllium contributed to hazard estimates for deep groundwater at AOC 590, but did not exceed unity. The hazard estimate for the deep aquifer was 0.3. Arsenic was the sole contributor to both risk and hazard for the shallow aquifer at AOC 590. The risk estimate for the shallow aquifer was 4E-04, and the HI was 4. Figures 10.43.7 and 10.43.8 illustrate the groundwater data as a function of point specific risk and hazard projection, respectively.

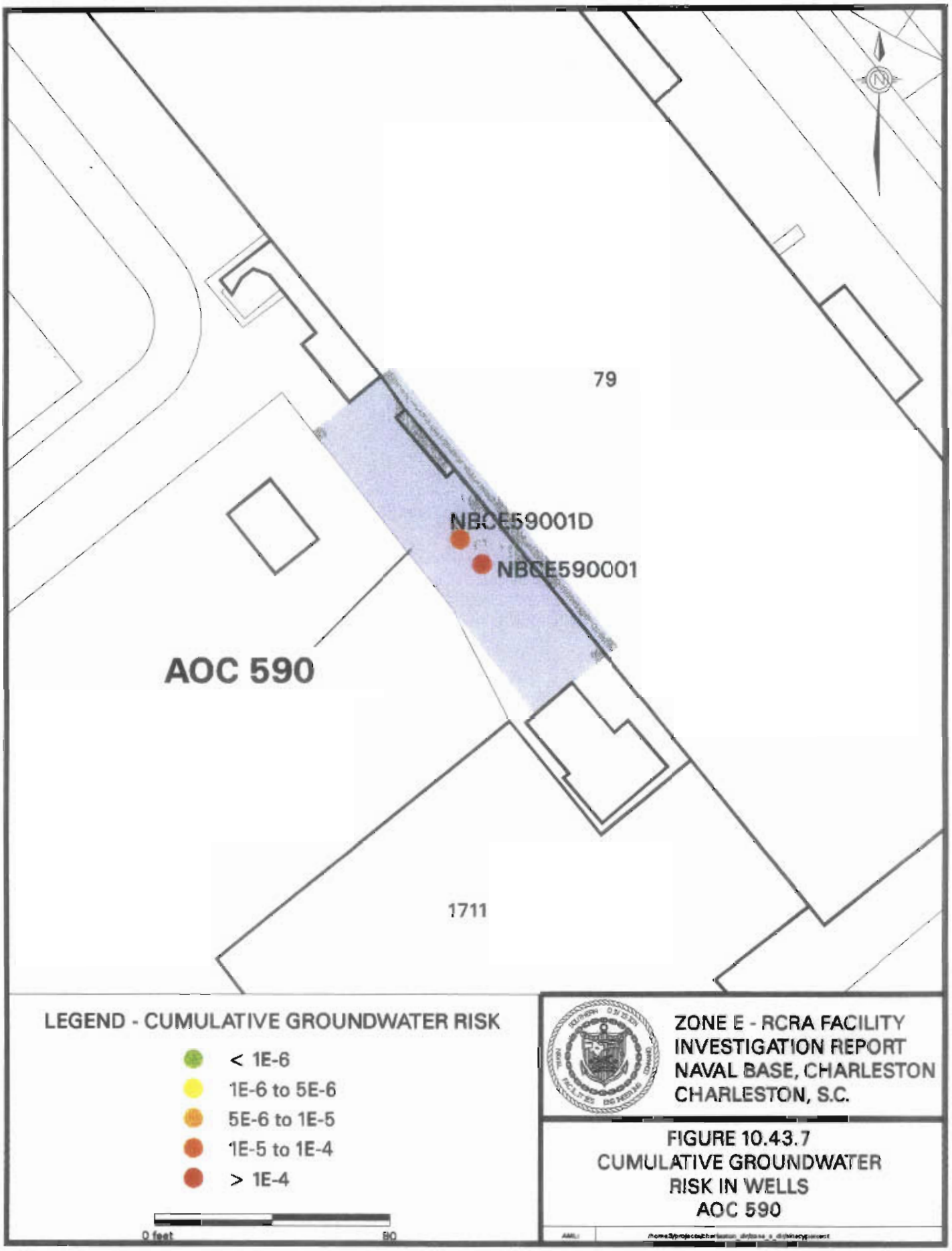
10.43.8.4 Uncertainty

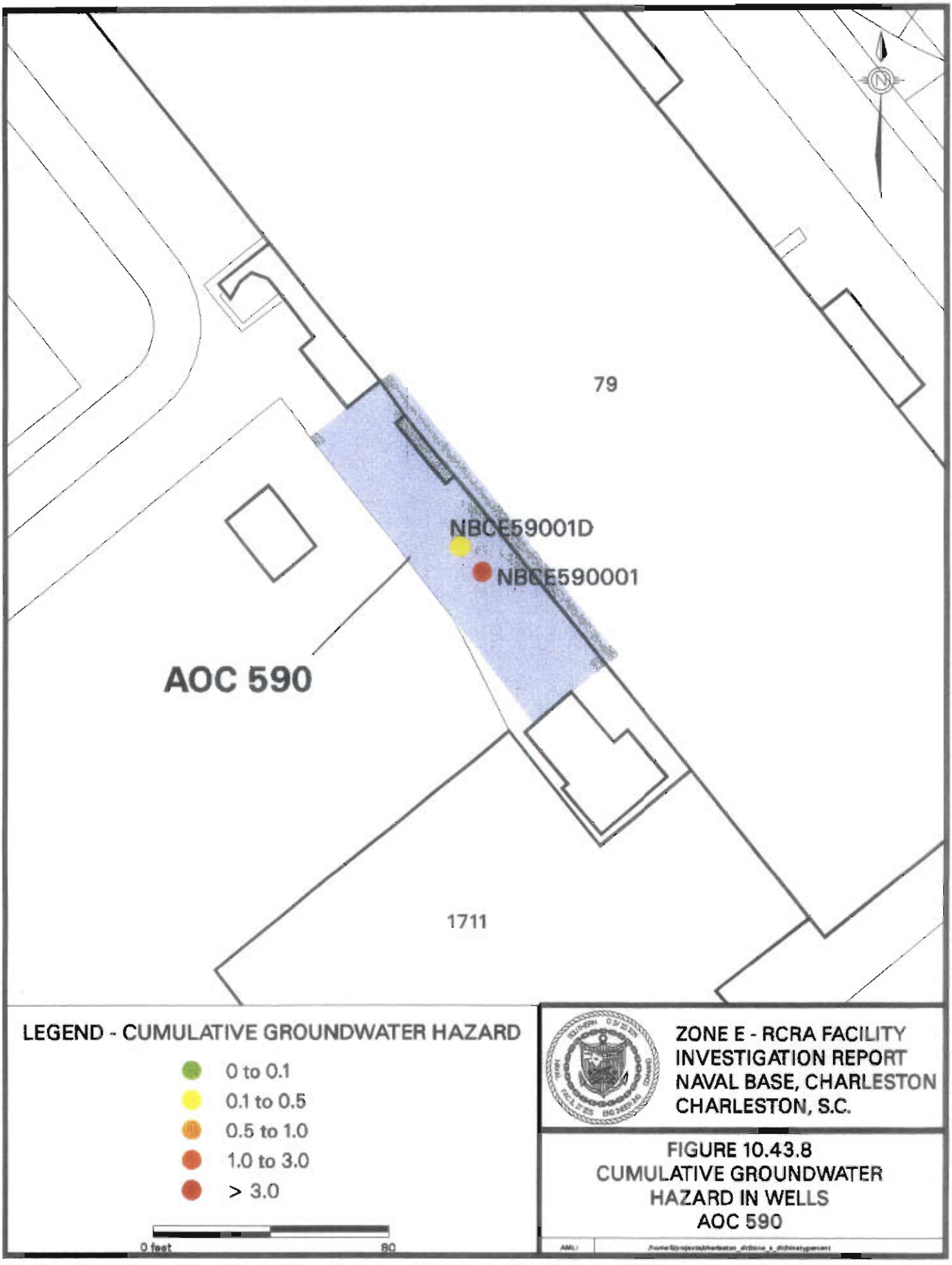
AOC 590 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.


79
NBCE59001D
NBCE590001
AOC 590
1711
LEGEND - CUMULATIVE GROUNDWATER RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
80
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.43.7
CUMULATIVE GROUNDWATER
RISK IN WELLS
AOC 590


79
NBCE59001D
NBCE590001
AOC 590
1711
LEGEND - CUMULATIVE GROUNDWATER HAZARD
0 to 0.1
0.1 to 0.5
0.5 to 1.0
1.0 to 3.0
> 3.0
0 feet
80
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.43.8
CUMULATIVE GROUNDWATER
HAZARD IN WELLS
AOC 590

Groundwater is not currently used as a potable water source at AOC 590, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 590. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBCs (e.g. within 10% of its RBCs).

Aluminum, arsenic, beryllium, and manganese were reported in AOC 590 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their corresponding background concentrations. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on

eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBCs (e.g. within 10% of its RBCs).

Manganese was reported in AOC 590 deep and shallow groundwater at maximum concentrations above its RBC benchmark, but was eliminated from consideration in the FRE based on comparison to corresponding background RCs for deep and shallow groundwater, respectively. As a result, its contribution to hazard has not been considered in the groundwater FRE.

10.43.8.5 FRE Summary

The risk and hazard posed by contaminants at AOC 590 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.43.8.2, 10.43.8.3, and 10.43.8.5, such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

BEQ equivalent compound were detected in AOC 590 surface soil at concentrations above their residential risk-based RGOs in five of six samples. The calculated mean risk estimate was 2E-05, which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Antimony, chromium, and mercury were detected in AOC 590 surface soil above their RBC benchmarks, but did not exceed their corresponding residential hazard-based RGOs in any of the

six surface soil samples. The calculated mean hazard estimate was 0.3, which is below USEPA's acceptable limit of unity.

Soil — Site Worker Scenario

BEQ equivalent compounds and arsenic were detected in AOC 590 surface soil at concentrations above their industrial risk-based RGOs in five of six samples. The calculated mean risk estimate was 3E-06, which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

No COPCs were detected in AOC 590 surface soil that would have contributed to industrial hazard estimates.

Groundwater — Residential Scenario

Beryllium was the sole contributor to the risk projection for deep groundwater, and was detected at a concentration above its RGO in the first quarter groundwater sample collected from the deep aquifer. Arsenic was reported in the shallow aquifer during the first quarter at a concentration above its RGO. Subsequent quarterly samples collected from the deep aquifer reported concentrations of beryllium below its background RC in the second and third quarters, and nondetect in the fourth quarter. Neither arsenic nor beryllium were reported at concentrations above their MCLs through four quarters of sampling.

Table 10.43.8.1
Chemicals Present in Site Samples
AOC 590 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Carcinogenic PAHs															
B(a)P Equiv.	* *	6	6	17.8	2865.7	983	NA	NA	88	780	NA	UG/KG	5	2	
Benzo(a)anthracene	*	5	6	340	1800	804	840	840	880	7800	NA	UG/KG	2		
Benzo(b)fluoranthene	*	6	6	86	1700	633	NA	NA	880	7800	NA	UG/KG	2		
Chrysene		5	6	430	1700	908	840	840	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	4	6	55	600	242	780	840	88	780	NA	UG/KG	3		
Indeno(1,2,3-cd)pyrene	*	6	6	92	1000	485	NA	NA	880	7800	NA	UG/KG	2		
Benzo(k)fluoranthene		5	6	220	1400	596	840	840	8800	78000	NA	UG/KG			
Benzo(a)pyrene	* *	5	6	300	1800	764	840	840	88	780	NA	UG/KG	5	2	
Total Petroleum Hydrocarbons															
Gasoline		1	1	6.3	6.3	6.3	NA	NA	NA	NA	NA	UG/KG			
Inorganics															
Aluminum (Al)		6	6	4490	15500	9633	NA	NA	7800	100000	26600	MG/KG	3		
Antimony (Sb)	*	6	6	0.54	11.6	2.7	NA	NA	3.1	82	1.77	MG/KG	1		2
Arsenic (As)		6	6	4	21.5	9.4	NA	NA	0.43	3.8	23.9	MG/KG	6	6	
Barium (Ba)		6	6	15.7	133	47.4	NA	NA	550	14000	130	MG/KG			1
Beryllium (Be)		6	6	0.22	0.83	0.46	NA	NA	0.15	1.3	1.7	MG/KG	6		
Cadmium (Cd)		6	6	0.15	0.9	0.48	NA	NA	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	6	6	6730	61100	24682	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)		6	6	17.1	91.2	52.2	NA	NA	39	1000	94.6	MG/KG	3		
Cobalt (Co)		6	6	1.2	9.9	3.6	NA	NA	470	12000	19	MG/KG			
Copper (Cu)		6	6	16.8	235	89.2	NA	NA	310	8200	66	MG/KG			3
Iron (Fe)	N	6	6	5070	18800	10782	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)	*	6	6	26	871	247	NA	NA	400	1300	265	MG/KG	1		2
Magnesium (Mg)	N	6	6	909	5220	2807	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)		6	6	52.4	239	133	NA	NA	180	4700	302	MG/KG	2		
Mercury (Hg)	*	6	6	0.27	9.9	2.22	NA	NA	2.3	61	2.6	MG/KG	1		1
Nickel (Ni)		6	6	6.5	22.8	13.45	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N	6	6	513	1720	895	NA	NA	NA	NA	NA	MG/KG			
Selenium (Se)		3	6	0.55	1.6	1.08	0.57	0.59	39	1000	1.7	MG/KG			
Sodium (Na)	N	6	6	83.9	472	215	NA	NA	NA	NA	NA	MG/KG			
Tin (Sn)		1	6	6	6	6	4.5	12.7	4700	6100	59.4	MG/KG			
Vanadium (V)		6	6	9.7	39.9	23.7	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)		6	6	67.4	429	204	NA	NA	2300	61000	827	MG/KG			

Table 10.43.8.1
Chemicals Present in Site Samples
AOC 590 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res.	Number Exceeding Ind.	Number Exceeding Ref.
Semivolatile Organics														
Acenaphthene	4	6	63	950	368	760	840	470000	12000000	NA	UG/KG			
Anthracene	4	6	120	870	420	760	840	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	5	6	180	1100	534	840	840	310000	8200000	NA	UG/KG			
bis(2-Ethylhexyl)phthalate	1	6	180	180	180	430	840	46000	410000	NA	UG/KG			
Dibenzofuran	1	6	260	260	260	430	840	31000	820000	NA	UG/KG			
Di-n-butylphthalate	1	6	100	100	100	430	840	780000	20000000	NA	UG/KG			
Fluoranthene	6	6	130	3800	1510	NA	NA	310000	8200000	NA	UG/KG			
Fluorene	3	6	92	490	264	430	840	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	1	6	120	120	120	430	840	310000	8200000	NA	UG/KG			
Naphthalene	1	6	660	660	660	430	840	310000	8200000	NA	UG/KG			
Phenanthrene	5	6	280	3500	1322	840	840	310000	8200000	NA	UG/KG			
Pyrene	6	6	130	2600	1282	NA	NA	230000	6100000	NA	UG/KG			
Volatile Organics														
Acetone	5	5	57	200	113	NA	NA	780000	20000000	NA	UG/KG			
2-Butanone	4	5	8	15	11.25	13	13	4700000	100000000	NA	UG/KG			
Carbon disulfide	2	5	1	2	1.5	6	6	780000	20000000	NA	UG/KG			
Toluene	1	5	1	1	1	6	6	1600000	41000000	NA	UG/KG			
Xylene (Total)	2	5	2	2	2	6	6	16000000	100000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.43.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 590
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
590	B001	Antimony (Sb)	0.63	MG/KG	0.0216	26.75	NA	
590	B001	B(a)P Equiv.	2865.70	UG/KG	NA		47.4569	100.00
590	B001	Chromium	17.10	MG/KG	0.0468	57.97	NA	
590	B001	Lead (Pb)	70.90	MG/KG	NA		NA	
590	B001	Mercury (Hg)	0.27	MG/KG	0.0123	15.29	NA	
		Total			0.0807		47.4569	
590	B002	Antimony (Sb)	11.60	MG/KG	0.3977	82.87	NA	
590	B002	B(a)P Equiv.	1445.10	UG/KG	NA		23.9313	100.00
590	B002	Chromium	21.50	MG/KG	0.0589	12.27	NA	
590	B002	Lead (Pb)	133.00	MG/KG	NA		NA	
590	B002	Mercury (Hg)	0.51	MG/KG	0.0233	4.86	NA	
		Total			0.4799		23.9313	
590	B003	Antimony (Sb)	0.73	MG/KG	0.0250	10.28	NA	
590	B003	B(a)P Equiv.	547.22	UG/KG	NA		9.0621	100.00
590	B003	Chromium	73.10	MG/KG	0.2001	82.21	NA	
590	B003	Lead (Pb)	301.00	MG/KG	NA		NA	
590	B003	Mercury (Hg)	0.40	MG/KG	0.0183	7.51	NA	
		Total			0.2434		9.0621	
590	B004	Antimony (Sb)	0.65	MG/KG	0.0223	3.98	NA	
590	B004	B(a)P Equiv.	570.69	UG/KG	NA		9.4508	100.00
590	B004	Chromium	31.10	MG/KG	0.0851	15.20	NA	
590	B004	Lead (Pb)	77.10	MG/KG	NA		NA	
590	B004	Mercury (Hg)	9.90	MG/KG	0.4525	80.82	NA	
		Total			0.5599		9.4508	
590	B005	Antimony (Sb)	0.54	MG/KG	0.0185	6.88	NA	
590	B005	B(a)P Equiv.	17.80	UG/KG	NA		0.2948	100.00
590	B005	Chromium	79.10	MG/KG	0.2166	80.54	NA	
590	B005	Lead (Pb)	26.00	MG/KG	NA		NA	
590	B005	Mercury (Hg)	0.74	MG/KG	0.0338	12.58	NA	
		Total			0.2689		0.2948	
590	B006	Antimony (Sb)	2.30	MG/KG	0.0788	19.86	NA	
590	B006	B(a)P Equiv.	448.63	UG/KG	NA		7.4295	100.00
590	B006	Chromium	91.20	MG/KG	0.2497	62.88	NA	
590	B006	Lead (Pb)	871.00	MG/KG	NA		NA	
590	B006	Mercury (Hg)	1.50	MG/KG	0.0686	17.27	NA	
		Total			0.3971		7.4295	

Table 10.43.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 590
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
590	B001	B(a)P Equiv.	2865.70	UG/KG	NA		9.6492	100.00
		Total			NA		9.6492	
590	B002	B(a)P Equiv.	1445.10	UG/KG	NA		4.8659	100.00
		Total			NA		4.8659	
590	B003	B(a)P Equiv.	547.22	UG/KG	NA		1.8426	100.00
		Total			NA		1.8426	
590	B004	B(a)P Equiv.	570.69	UG/KG	NA		1.9216	100.00
		Total			NA		1.9216	
590	B005	B(a)P Equiv.	17.80	UG/KG	NA		0.0599	100.00
		Total			NA		0.0599	
590	B006	B(a)P Equiv.	448.63	UG/KG	NA		1.5106	100.00
		Total			NA		1.5106	

Table 10.43.8.4
Chemicals Present in Site Samples
AOC 590 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Deep Wells													
Barium (Ba)	*	1	1	281	281	281	NA	NA	260	218	UG/L	1	1
Beryllium (Be)	*	1	1	1.3	1.3	1.3	NA	NA	0.016	1.2	UG/L	1	1
Calcium (Ca)	N	1	1	224000	224000	224000	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	730000	730000	730000	NA	NA	NA	NA	UG/L		
Manganese (Mn)		1	1	197	197	197	NA	NA	84	869	UG/L	1	
Potassium (K)	N	1	1	282000	282000	282000	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	7260000	7260000	7260000	NA	NA	NA	NA	UG/L		
Vanadium (V)		1	1	3.3	3.3	3.3	NA	NA	26	5.3	UG/L		
Volatile Organics													
Acetone		1	1	16	16	16	NA	NA	370	NA	UG/L		
Shallow Wells													
Arsenic (As)	*	1	1	19.9	19.9	19.9	NA	NA	0.045	18.7	UG/L	1	1
Calcium (Ca)	N	1	1	97300	97300	97300	NA	NA	NA	NA	UG/L		
Iron (Fe)	N	1	1	18800	18800	18800	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	49500	49500	49500	NA	NA	NA	NA	UG/L		
Manganese (Mn)		1	1	730	730	730	NA	NA	84	2560	UG/L	1	
Potassium (K)	N	1	1	41400	41400	41400	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	537000	537000	537000	NA	NA	NA	NA	UG/L		
Vanadium (V)		1	1	2.3	2.3	2.3	NA	NA	26	11.4	UG/L		

Notes:
* - Identified as a COPC
N - Essential nutrient
UG/L - microgram per liter
SQL - Sample quantitation limit
RBC - Risk-based Concentration
NA - Not Applicable

Table 10.43.8.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 590
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
590	G01D	Barium (Ba)	281	UG/L	0.2555	93.89	NA	
590	G01D	Beryllium (Be)	1.30	UG/L	0.0166	6.11	83.1389	100.00
		Total			0.2721		83.1389	
590	G001	Arsenic (As)	19.90	UG/L	4.2405	100.00	443.9530	100.00
		Total			4.2405		443.9530	

10.43.9 Corrective Measures Considerations

For AOC 590, the upper and lower soil intervals, sediment, and shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval and shallow and deep groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is paved with asphalt. Five of six soil samples were collected from beneath the pavement.

BEQs, antimony, chromium, lead, and mercury were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 2E-05 and the arithmetic mean HI is 0.3. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI. Soil sample 590SB005 had no COPCs.

Lead was identified at 590SB006 above USEPA's residential acceptable level of 400 mg/kg. The extent of the lead is not known.

Residential risk-based remedial goal for surface soil set for BEQs is 0.06 based on a target risk of 1E-06. Hazard-based remedial goals for surface soil set for antimony, chromium, and mercury are 29, 73, and 22 mg/kg, respectively, based on a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.43.9.1.

Arsenic was identified in the shallow groundwater at concentrations above its 1E-06 risk-based RGO of 0.000045 mg/L. The equated risk associated with arsenic is 4E-04 and its equated HI is 4. These are above USEPA's acceptable risk of 1E-04 and HI of 3. Potential corrective measures, in addition to no further action for shallow groundwater, are presented in Table 10.43.9.1. Corrective measures for AOC 590 are detailed in Section 9.

Beryllium was identified in the deep groundwater at concentrations that equal a risk above 1E-06 and/or an HI above 1. The calculated risk estimate associated with beryllium was equated as 8E-05. The associated risk exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 and 1E-04 acceptable risk range. Potential corrective measures for the deep groundwater, in addition to no further action, are presented in Table 10.43.9.1. Corrective measures for AOC 590 are detailed in Section 9.

Table 10.43.9.1
Potential Corrective Measures for AOC 590

Medium	Compounds	Potential Corrective Measures
Soil	Antimony, chromium, lead, mercury, and BEQs	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment
Deep Groundwater	Beryllium	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.44 AOC 592, Asbestos-Shredding Shelter, Former Building 1225

AOC 592 is a former asbestos-shredding shelter which was located in former Building 1225. Built in 1944, the building was used for this purpose until it was removed in 1955. From 1955 until 1966, the site was a pipe storage area. After 1966, the area was vacated. Currently the site is paved and bisected by a railroad spur.

The material of concern identified in the *Final Zone E RFI Work Plan* is asbestos. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

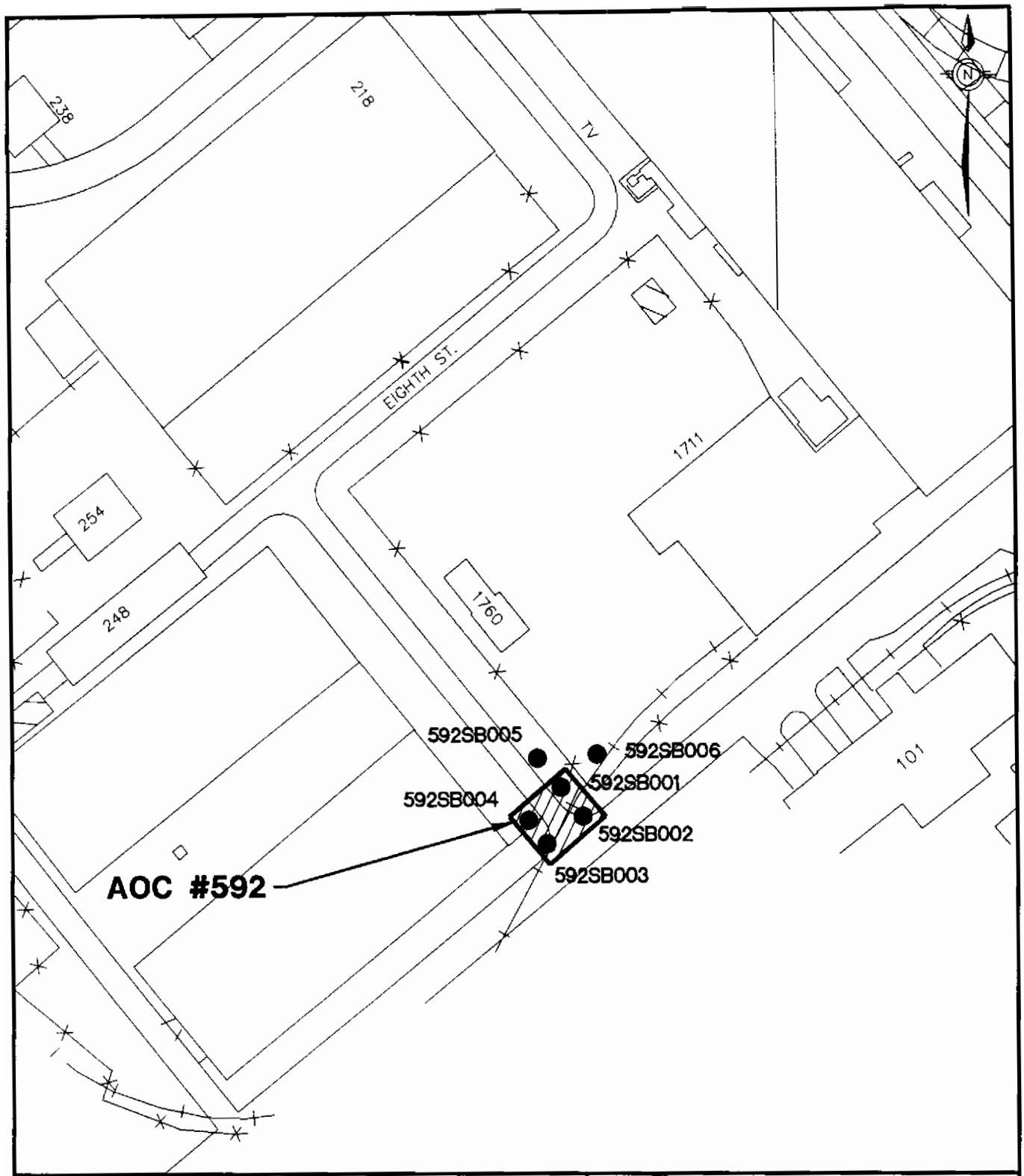
To fulfill the CSI objectives for AOC 592, air and soil were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.44.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 592 from the locations shown in Figure 10.44.1. The *Final Zone E RFI Work Plan*, proposed collecting four soil samples from the upper interval, and four samples from the lower interval.

First-round Sampling — During the first round of sampling, all four proposed upper- and lower-interval samples were collected. No duplicate soil samples were collected from AOC 592.

First-round samples were submitted to International Asbestos Testing Laboratories (IATL) for asbestos analysis. Table 10.44.1.1 summarizes the first round of soil sampling at AOC 592.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.44.1
SOIL BORING LOCATIONS
AOC #592
ASBESTOS SHREDDING SHELTER
FORMER BUILDING 1225

DWG DATE: 09/02/97 | DWG NAME: 10-44-1

Table 10.44.1.1
AOC 592
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	Asbestos	Asbestos	None
Lower	4	4	Asbestos	Asbestos	None

Second-round Sampling — Second-round sampling was performed at AOC 592 after first-round analytical results were evaluated. Results from 592SB00101 indicated 2.3% chrysotile asbestos, and 0.75% amosite asbestos were present.

Second-round included two upper- and two lower-interval samples to determine the extent of asbestos detected during first-round sampling. Both of the proposed upper-interval samples and one of the two proposed lower-interval samples were collected. One lower-interval sample was not collected due to subsurface obstructions such as wood or rocks.

Second-round samples were submitted to IATL for asbestos analysis. No duplicate samples were collected at AOC 592. Table 10.44.1.2 summarizes the second round of soil sampling at AOC 592.

Table 10.44.1.2
AOC 592
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	2	2	Asbestos	Asbestos	None
Lower	2	1	Asbestos	Asbestos	One sample was not collected due to subsurface obstructions

10.44.2 Nature of Contamination in Soil

Analytical results for asbestos in soil are summarized in Table 10.44.2.1.

Table 10.44.2.1
AOC 592
Asbestos Detections for Soil (%)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.
Chrysotile asbestos	Upper	1/6	2.3	2.3
Amosite asbestos	Upper	1/6	0.75	0.75

Asbestos in Soil

Asbestos was detected in one of six upper-interval samples at AOC 592. Results from sample 592SB00101 indicated 2.3% chrysotile asbestos and 0.75% amosite asbestos. Asbestos was not detected in any of the lower-interval samples at this site. No RBCs exist for comparison of asbestos in soil. Appendix H contains the complete data report for all samples collected in Zone E.

10.44.3 Air Sampling and Analysis

Air was sampled from AOC 592. The *Final Zone E RFI Work Plan*, proposed collecting five air samples from areas both up- and downwind, including stations to the north, south, and in the center of the site. A summary of the air sampling conducted at AOC 592 is presented in Table 10.44.3.1.

Table 10.44.3.1
AOC 592
Air Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
5	5	Asbestos	Asbestos	None
5	5	Asbestos	Asbestos	None

10.44.4 Nature of Contamination in Air

Asbestos was not detected in any of the five air samples at AOC 592. Appendix H contains the complete data report for all samples collected in Zone E.

10.44.5 Fate and Transport Assessment for AOC 592

AOC 592 is a former asbestos-shredding shelter located in former Building 1225. The site is currently paved, except for a small grassy area, and is bisected by a railroad spur. Environmental media sampled as part of the AOC 592 CSI include asbestos in soil and air samples. Because no RBCs or fate and transport screening criteria exist for asbestos in soil, migration pathways for asbestos at AOC 592 were not evaluated.

10.44.6 Human Health Risk Assessment

Soil and air were sampled for the presence of asbestos during the investigation of AOC 592. A formal risk assessment was not conducted for this site.

10.44.7 Corrective Measures Considerations

Asbestos was detected in only one soil sample at AOC 592; therefore, no corrective measures were considered for the site.

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10.45 AOC 596, Former Torpedo Storage, Building 101

AOC 596 is the site of a former torpedo storage area located in Building 101. Building 101 was built in 1919 and was used to store torpedoes until 1943. From 1943 to 1946, the building housed a machine shop. In 1946, the building was converted into a storehouse for diesel parts and in 1947 it was used as a storage house for a galvanizing plant. From 1981 to present, it has been used to store radioactive-contaminated material. SWMU 155 addresses mixed-waste storage within Building 101.

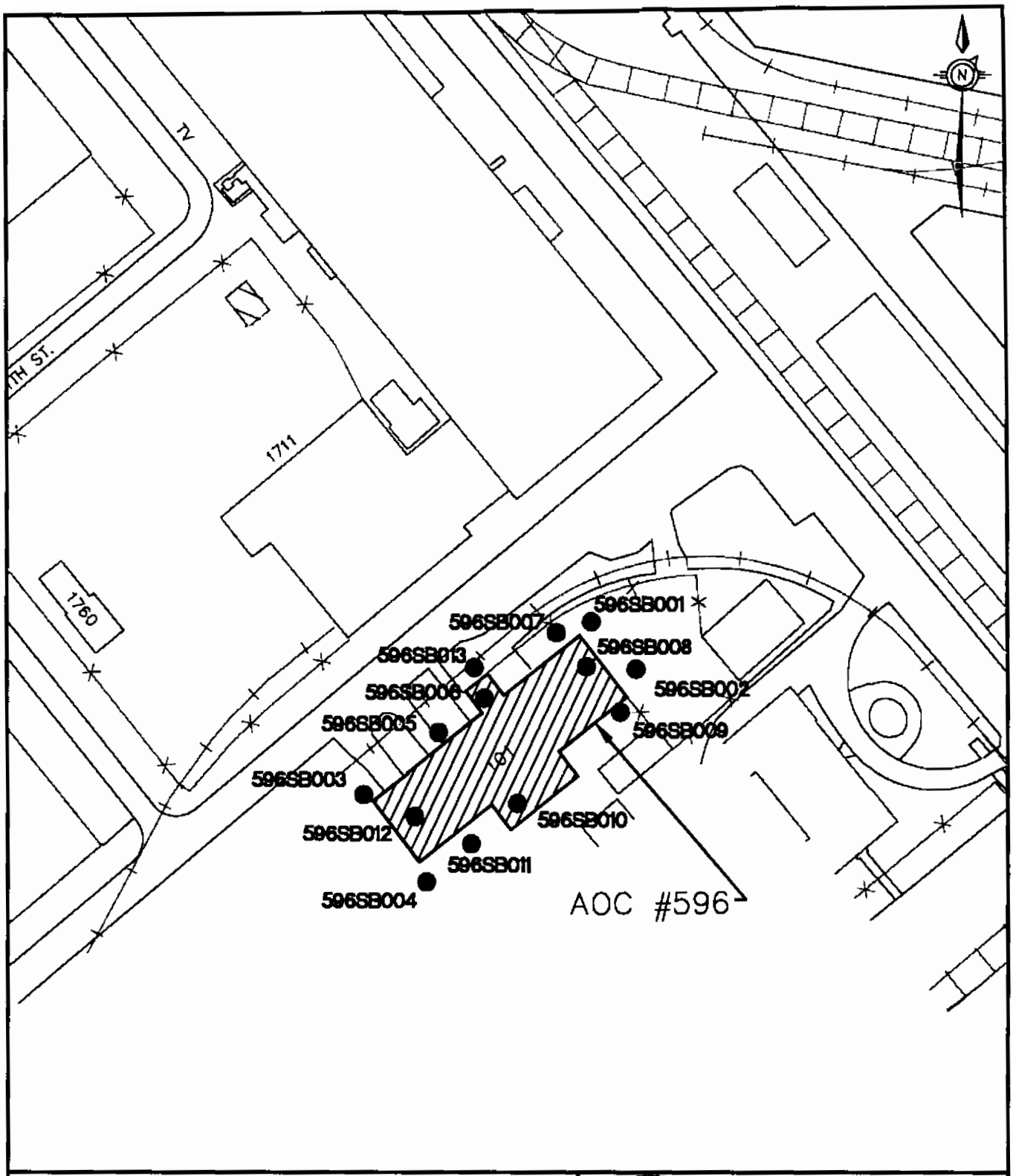
Materials of concern identified in the *Final Zone E RFI Work Plan* include solvents, degreasers, explosives, propellants, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 596, soil and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.45.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 596 from the locations shown in Figure 10.45.1. The *Final Zone E RFI Work Plan*, proposed collecting eight soil samples from the upper interval and eight samples from the lower interval. Soil samples were also collected at both intervals for the four shallow monitoring well locations proposed at this site.

First-round Sampling — During the first round of sampling, 11 of the proposed 12 upper-interval samples and 11 of the 12 proposed lower-interval samples were collected. One sample location, 596SB008, was abandoned due to the extreme thickness of the cement (greater than three feet) floor in Building 101.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.1
SOIL SAMPLE LOCATIONS
AOC #596
FORMER TORPEDO STORAGE
BUILDING 101

DWG DATE: 09/02/97 | DWG NAME: 10-45-1

All first round samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. No duplicate samples were collected at AOC 596. Table 10.45.1.1 summarizes the first round of soil sampling.

Table 10.45.1.1
AOC 596
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	12	11	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was abandoned due to thick cement
Lower	12	11	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was abandoned due to thick cement

Second-round Sampling — Second-round sampling was performed at AOC 596 after first-round analytical results were compared to the USEPA Region III RBCs (April 1996). Parameters exceeding RBCs included SVOCs and metals. Section 10.45.2 details specific parameters and locations which exceeded RBCs.

The second round included one upper- and one lower-interval sample to determine the extent of constituents detected during first-round sampling. Samples were collected from both intervals during second-round sampling. No duplicate soil samples were collected during second-round sampling.

Second-round samples at AOC 596 were submitted for analysis of VOCs, SVOCs, and metals. Table 10.45.1.2 summarizes the second round of soil sampling at AOC 596.

Table 10.45.1.2
AOC 596
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	1	1	VOCs, SVOCs, and metals	VOCs, SVOCs, pesticides, and metals	Pesticide analysis inadvertently added
Lower	1	1	VOCs, SVOCs, and metals	VOCs, SVOCs, pesticides, and metals	Pesticide analysis inadvertently added

10.45.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.45.2.1. Inorganic analytical results for soil are summarized in Table 10.45.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.45.2.1
AOC 596
Organic Compounds Detected in Soil (µg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	1/12	150	150	20,000,000	0
	Lower	1/12	260	260	NA	NA
2-Butanone (MEK)	Upper	3/12	6.00 - 12.0	9.33	100,000,000	0
	Lower	3/12	7.00 - 48.0	24.7	NA	NA
Carbon disulfide	Upper	3/12	2.00 - 4.00	2.67	20,000,000	0
	Lower	3/12	2.00 - 6.00	3.33	NA	NA
Ethylbenzene	Upper	1/12	7.00	7.00	20,000,000	0
Methylene chloride	Upper	1/12	2.00	2.00	760,000	0
Toluene	Upper	2/12	1.000 - 2.00	1.50	41,000,000	0

Table 10.45.2.1
AOC 596
Organic Compounds Detected in Soil (µg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Xylene (Total)	Upper	1/12	150	150	100,000,000	0
	Lower	1/12	3.00	3.00	NA	NA
SVOCs						
Acenaphthene	Upper	2/12	1,100 - 20,000	10,600	12,000,000	0
	Lower	1/12	280	280	NA	NA
Anthracene	Upper	2/12	210 - 2,500	1,360	61,000,000	0
	Lower	1/12	570	570	NA	NA
Benzo(g,h,i)perylene	Upper	5/12	110 - 36,000	7,710	8,200,000	0
	Lower	1/12	820	820	NA	NA
bis(2-Ethylhexyl)phthalate	Upper	3/12	86.0 - 130	105	410,000	0
	Lower	1/12	420	420	NA	NA
4-Bromophenyl-phenylether	Lower	1/12	230	230	NA	NA
Butylbenzylphthalate	Upper	1/12	210	210	41,000,000	0
Dibenzofuran	Upper	3/12	120 - 26,000	9,000	820,000	0
	Lower	1/12	490	490	NA	NA
Fluoranthene	Upper	5/12	170 - 220,000	46,300	8,200,000	0
	Lower	2/12	240 - 4,000	2,120	NA	NA
Fluorene	Upper	3/12	120 - 18,000	6,440	8,200,000	0
	Lower	1/12	170	170	NA	NA
Isophorone	Lower	1/12	1500	1,500	NA	NA
2-Methylnaphthalene	Upper	2/12	700 - 11,000	5,850	8,200,000	0
	Lower	1/12	270	270	NA	NA
Naphthalene	Upper	3/12	120 - 26,000	8,940	8,200,000	0
	Lower	1/12	880	880	NA	NA
N-Nitroso-di-n-propylamine	Lower	1/12	500	500	NA	NA

Table 10.45.2.1
AOC 596
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs						
Phenanthrene	Upper	6/12	96.0 - 220,000	38,500	8,200,000	0
	Lower	2/12	190 - 4,900	2,550	NA	NA
Pyrene	Upper	8/12	140 - 160,000	21,200	6,100,000	0
	Lower	2/12	210 - 3,700	1,960	NA	NA
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	8/12	11.1 - 89,900	12,000	780	2
	Lower	2/12	88.8 - 2,100	1,090	NA	NA
Benzo(a)anthracene	Upper	7/12	100 - 70,000	10,600	7,800	1
	Lower	2/12	86.0 - 1,300	693	NA	NA
Benzo(b)fluoranthene	Upper	6/12	91.0 - 58,000	10,200	7,800	1
	Lower	2/12	72.0 - 1,300	686	NA	NA
Chrysene	Upper	8/12	110 - 82,000	10,900	780,000	0
	Lower	2/12	100 - 1,800	950	NA	NA
Dibenz(a,h)anthracene	Upper	4/12	110 - 18,000	4,790	780	2
	Lower	1/12	340	340	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	5/12	92.0 - 34,000	7,220	7,800	1
	Lower	1/12	810	810	NA	NA
Benzo(k)fluoranthene	Upper	6/12	86.0 - 58,000	10,300	78,000	0
	Lower	2/12	87.0 - 1,500	794	NA	NA
Benzo(a)pyrene	Upper	7/12	91.0 - 55,000	8,420	780	2
	Lower	2/12	72.0 - 1,400	736	NA	NA
Pesticides						
4,4'-DDT	Upper	1/1	11.0	11.0	17,000	0
Heptachlor	Upper	1/1	2.00	2.00	1,300	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.45.2.2
AOC 596
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	12/12	2,070 - 11,300	6,020	100,000	26,600	0
	Lower	12/12	2,080 - 19,700	10,800	NA	41,100	NA
Antimony (Sb)	Upper	10/12	0.480 - 2.30	1.49	82.0	1.77	0
	Lower	4/12	0.490 - 1.000	0.728	NA	1.60	NA
Arsenic (As)	Upper	12/12	5.10 - 155	20.9	3.80	23.9	1
	Lower	12/12	3.20 - 38.7	14.1	NA	19.9	NA
Barium (Ba)	Upper	12/12	18.8 - 110	41.7	14,000	130	0
	Lower	12/12	6.20 - 96.4	27.3	NA	94.1	NA
Beryllium (Be)	Upper	12/12	0.290 - 0.870	0.478	1.30	1.70	0
	Lower	12/12	0.130 - 1.30	0.676	NA	2.71	NA
Cadmium (Cd)	Upper	11/12	0.170 - 1.70	0.684	100	1.50	0
	Lower	6/12	0.220 - 0.740	0.452	NA	0.960	NA
Calcium (Ca)	Upper	12/12	2,280 - 179,000	37,900	NA	NA	NA
	Lower	12/12	1,420 - 64,800	24,700	NA	NA	NA
Chromium (Cr)	Upper	12/12	10.6 - 93.1	29.4	1,000	94.6	0
	Lower	12/12	3.70 - 51.3	24.1	NA	75.2	NA
Cobalt (Co)	Upper	12/12	1.10 - 97.5	14.2	12,000	19.0	0
	Lower	12/12	1.20 - 12.5	4.05	NA	14.9	NA
Copper (Cu)	Upper	12/12	8.70 - 194	43.8	8,200	66.0	0
	Lower	12/12	1.90 - 51.2	19.1	NA	152	NA
Iron (Fe)	Upper	12/12	4,570 - 19,300	9,390	61,000	NA	0
	Lower	12/12	2,610 - 41,300	16,300	NA	NA	NA
Lead (Pb)	Upper	12/12	25.7 - 317	109	1,300	265	0
	Lower	12/12	5.80 - 65.4	29.4	NA	173	NA
Magnesium (Mg)	Upper	12/12	373 - 5,630	1,980	NA	NA	NA
	Lower	12/12	231 - 5,790	2,920	NA	NA	NA

Table 10.45.2.2
AOC 596
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Manganese (Mn)	Upper	12/12	37.9 - 184	84.7	4,700	302	0
	Lower	12/12	19.6 - 873	237	NA	881	NA
Mercury (Hg)	Upper	12/12	0.0400 - 0.390	0.150	61	2.60	0
	Lower	10/12	0.0300 - 0.330	0.132	NA	1.59	NA
Nickel (Ni)	Upper	12/12	3.50 - 20.3	10.6	4,100	77.1	0
	Lower	12/12	2.10 - 18.0	9.38	NA	57.0	NA
Potassium (K)	Upper	11/12	398 - 1,710	1,070	NA	NA	NA
	Lower	9/12	491 - 3,840	2,250	NA	NA	NA
Selenium (Se)	Upper	9/12	0.590 - 2.00	1.10	1,000	1.70	0
	Lower	10/12	0.790 - 2.90	1.75	NA	2.40	NA
Sodium (Na)	Upper	10/12	140 - 1,130	371	NA	NA	NA
	Lower	10/12	171 - 880	419	NA	NA	NA
Thallium (Tl)	Upper	3/12	0.660 - 1.10	0.820	16	2.80	0
	Lower	5/12	0.640 - 2.30	1.35	NA	NA	NA
Tin (Sn)	Upper	8/12	3.70 - 42.3	11.2	100,000	59.4	0
	Lower	9/12	3.20 - 17.9	6.56	NA	9.23	NA
Vanadium (V)	Upper	12/12	11.8 - 35.6	20.1	1,400	94.3	0
	Lower	12/12	5.60 - 71.5	34.0	NA	155	NA
Zinc (Zn)	Upper	12/12	29.4 - 270	130	61,000	827	0
	Lower	12/12	10.4 - 206	76.3	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Seven VOCs were detected in soil samples collected at AOC 596. Twelve detections occurred in the upper interval and eight in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-two SVOCs were detected in soil samples collected at AOC 596. Eighty-six detections occurred in the upper interval and 29 in the lower interval. Five SVOCs — Benzo(a)pyrene, dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene — exceeded their respective industrial RBC in the upper interval. Additionally, four SVOCs — benzo(a)anthracene, chrysene, isophorone, n-nitroso-di-n-propylamine — exceeded their respective SSL in the lower interval.

Benzo(a)anthracene was detected in seven of twelve upper-interval samples with a range of 100 to 70,000 μg/kg and a mean of 10,600 μg/kg. One upper-interval sample (596SB006, 70,000 μg/kg) exceeded the benzo(a)anthracene RBC of 7,800 μg/kg. Benzo(a)anthracene was detected in two of 12 lower-interval samples with a range of 86 to 1,300 μg/kg and a mean of 693 μg/kg. One lower-interval sample (596SB006, 1,300 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Benzo(b)fluoranthene was detected in six of twelve upper-interval samples with a range of 91.0 to 58,000 μg/kg and a mean of 10,200 μg/kg. One upper-interval sample (596SB006, 58,000 μg/kg) exceeded the benzo(b)fluoranthene RBC of 7,800 μg/kg.

Benzo(a)pyrene was detected in seven of 12 upper-interval samples with a range of 91.0 to 55,000 μg/kg and a mean of 8,420 μg/kg. Two upper-interval samples (596SB006, 55,000 μg/kg; 596SB013, 2,800 μg/kg) exceeded the Benzo(a)pyrene RBC of 780 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 596. The BEQ was calculated for eight upper-interval samples with a range of 11.1 to 89,900 μg/kg and a mean of 12,000μg/kg. Two samples (596SB006, 89,900 μg/kg; 596SB013, 4,452 μg/kg) exceeded the BEQ industrial RBC of 780.0 μg/kg.

Chrysene was detected in two of 12 lower-interval samples with a range of 100 to 1,800 μg/kg and a mean of 950 μg/kg. One lower-interval sample (596SB006, 1,800 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

Dibenz(a,h)anthracene was detected in four of twelve upper-interval samples with a range of 110 to 18,000 μg/kg and a mean of 4,790 μg/kg. Two upper-interval samples (596SB006, 18,000 μg/kg; 596SB013, 870 μg/kg) exceeded the dibenz(a,h)anthracene RBC of 780 μg/kg.

Indeno(1,2,3-cd)pyrene was detected in five of twelve upper-interval samples with a range of 92.0 to 34,000 μg/kg and a mean of 7,220 μg/kg. One upper-interval sample (596SB006, 34,000 μg/kg) exceeded the indeno(1,2,3-cd)pyrene RBC of 7,800 μg/kg.

Isophorone was detected in one of 12 lower-interval samples at 1,500 μg/kg. One lower-interval sample (596SB005, 1,500 μg/kg) exceeded the isophorone SSL of 200 μg/kg.

N-nitroso-di-n-propylamine was detected in one of 12 lower-interval samples at 500 μg/kg. One lower-interval sample (596SB005, 500 μg/kg) exceeded the n-nitroso-di-n-propylamine SSL of 200 μg/kg.

Pesticides in Soil

Two pesticides were detected in soil samples collected at AOC 596. Two detections occurred in the upper interval; no lower interval samples were collected. Neither pesticide exceeded its respective industrial RBC in the upper interval.

Inorganic Elements in Soil

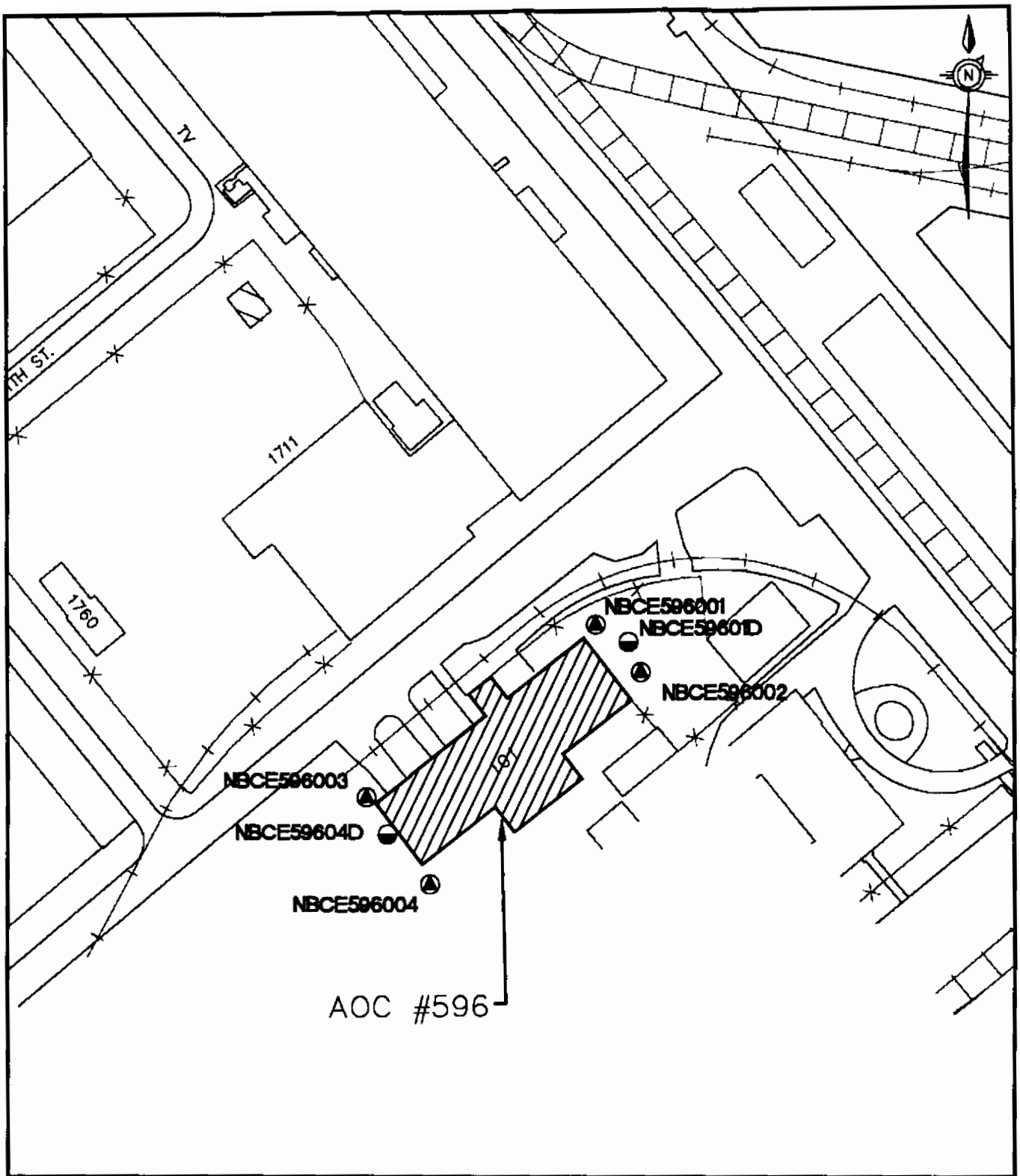
Twenty-three metals were detected in soil samples collected at AOC 596. Two hundred and fifty-four detections occurred in the upper interval and 231 occurred in the lower interval. One metal — arsenic — exceeded both its respective industrial RBC and background RC in the upper interval. Additionally, two metals — arsenic and barium — exceeded both their respective SSL and background RC in the lower interval.

Arsenic was detected in 12 of 12 upper-interval samples with a range of 5.10 to 155 mg/kg and a mean of 20.9 mg/kg. One upper-interval sample (596SB006, 155 mg/kg) exceeded both the arsenic industrial RBC of 3.8 mg/kg and the background RC of 23.9 mg/kg. Arsenic was detected in 12 of 12 lower-interval samples with a range of 3.20 to 38.7 mg/kg and a mean of 14.1 mg/kg. Three lower-interval samples (596SB007, 22 mg/kg; 596SB010, 38.7 mg/kg; and 596SB011, 21 mg/kg) exceeded both the arsenic SSL of 15 mg/kg and the background RC of 19.9 mg/kg.

Barium was detected in 12 of 12 lower-interval samples with a range of 6.20 to 96.4 mg/kg and a mean of 27.3 mg/kg. One lower-interval sample (596SB006, 96.4 mg/kg) exceeded both the barium SSL of 32 mg/kg and the background RC of 94.1 mg/kg.

10.45.3 Groundwater Sampling and Analysis

Two deep monitoring wells and four shallow monitoring wells were installed and sampled to assess groundwater quality at AOC 596 as shown in Figure 10.45.2. The wells were installed as follows:



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.2
MONITORING WELL LOCATIONS
AOC #596
FORMER TORPEDO STORAGE
BUILDING 101

DWG DATE: 09/02/97 | DWG NAME: 10-45-2

- Shallow Wells – NBCE596001, NBCE596002, NBCE596003, NBCE596004
- Deep Wells – NBCE59601D, NBCE59604D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. One duplicate sample was collected from a shallow monitoring well and submitted for Appendix IX analyses at DQO Level IV, which includes the parameters listed above plus a more comprehensive list of VOCs and SVOCs as well as herbicides, hexavalent chromium, organophosphorous pesticides, and dioxins. Table 10.45.3.1 summarizes groundwater sampling and analysis at AOC 596.

Table 10.45.3.1
AOC 596
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	4	4	VOCs, SVOCs, metals	VOCs, SVOCs, metals	None
Deep	2	2	VOCs, SVOCs, metals	VOCs, SVOCs, metals	None

The shallow monitoring wells were installed at 13 feet bgs in the surficial aquifer. The deep wells were installed at 32.1 and 33.6 bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.45.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow groundwater are summarized in Table 10.45.4.1. No organic compounds were detected in deep groundwater. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.45.4.2 and 10.45.4.3, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.45.4.1
AOC 596
Organic Compounds Detected in First Quarter Groundwater (pg/L)
Shallow Monitoring Wells

Compound	Freq. Of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
Dioxins						
Dioxin Equiv.	1/1	0.0087	0.0087	0.4	NA	0
OCDD	1/1	8.72	8.72	NA	NA	NA

Notes:
pg/L = Picograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No RBC or MCL established

Table 10.45.4.2
AOC 596
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	4/4	229 - 535	336	3,700	2,810	NA	0
Arsenic (As)	2/4	7.60 - 11.0	9.30	0.0450	18.7	50.0	0
Chromium (Cr)	1/4	5.30	5.30	18.0	12.3	100	0
Iron (Fe)	1/4	11,000	11,000	1,100	NA	NA	1
Vanadium (V)	2/4	1.000 - 3.20	2.10	26.0	11.4	NA	0
Zinc (Zn)	3/4	10.5 - 14.7	12.0	1,100	27.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RC or MCL established

Table 10.45.4.3
AOC 596
Inorganic Detections for First Quarter Groundwater (µg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/2	26.1	26.1	3,700	319	NA	0
Arsenic (As)	2/2	13.5 - 43.8	28.7	0.0450	16.4	50.0	1
Barium (Ba)	2/2	32.5 - 45.1	38.8	260	218	2,000	0
Calcium (Ca)	2/2	174,000 - 177,000	176,000	NA	NA	NA	NA
Chromium (Cr)	1/2	1.10	1.10	18.0	15.5	100	0
Cobalt (Co)	2/2	5.90 - 10.1	8.00	220	12.9	NA	0
Iron (Fe)	2/2	3,200 - 8,170	5,690	1,100	NA	NA	2
Magnesium (Mg)	2/2	173,000 - 216,000	195,000	NA	NA	NA	NA
Manganese (Mn)	2/2	356 - 715	536	84.0	869	NA	0
Mercury (Hg)	2/2	0.200	0.200	1.10	0.2	2.00	0
Nickel (Ni)	2/2	13.3 - 15.3	14.3	73.0	42.2	100	0
Potassium (K)	2/2	18,100 - 35,800	27,000	NA	NA	NA	NA
Sodium (Na)	2/2	1,860,000 - 1,940,000	1,900,000	NA	NA	NA	NA
Vanadium (V)	2/2	1.10 - 1.30	1.20	26.0	5.3	NA	0

Notes:
µg/L = micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Other Organic Compounds in Groundwater

Shallow Groundwater

One dioxin — OCDD — was detected in the duplicate shallow groundwater sample collected at AOC 596. No tap-water RBC or MCL has been established for OCDD.

In accordance with recent dioxin guidance, the TEQ (dioxin equivalent) was calculated for the sample at 0.0087 pg/L, below the 2,3,7,8-TCDD tap-water RBC of 0.4 pg/L. No MCL has been established for dioxin equivalents.

Inorganic Elements in Groundwater

Shallow Groundwater

Six metals were detected in shallow groundwater samples collected at AOC 596. One metal — iron — exceeded its respective tap-water RBC.

Iron was detected in one of four samples in well NBCE596001 (11,000 μg/L), exceeding its tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

Fourteen metals were detected in deep groundwater samples collected at AOC 596. Two metals — arsenic and iron — exceeded their respective tap-water RBC and background deep groundwater RC (where available).

Arsenic was detected in two of two samples with a range of 13.5 to 43.8 μg/L and a mean of 28.7 μg/L. One sample from well NBCE59601D (43.8 μg/L) exceeded both the arsenic tap-water RBC of 0.0450 μg/L and deep groundwater RC of 16.4 μg/L. The detection did not exceed the arsenic MCL of 50.0 μg/L.

Iron was detected in two of two samples with a range of 3,200 to 8,170 μg/L and a mean of 5,960 μg/L. Two samples from wells NBCE59601D (8,170 μg/L) and NBCE59604D (3,200 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

10.45.5 Fate and Transport Assessment for AOC 596

AOC 596 is the site of a former torpedo storage area located in Building 101. Since 1943, the building was used as a machine shop, a storage house for diesel parts, a storage house for a galvanizing plant, and most recently, a storage house for radioactive-contaminated material. The building is on a concrete slab surrounded by other buildings and asphalt and concrete pavement. There is a small lawn south of Building 101 and a smaller grassy strip along part of the northwest side of the building. Environmental media sampled as part of the AOC 596 RFI include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for AOC 596 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.45.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.45.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background reference concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Nine organic compounds — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, isophorone, and n-nitroso-di-n-propylamine — were detected in AOC 596 soil at concentrations exceeding generic groundwater protection SSLs. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were all detected at concentrations exceeding their generic groundwater protection SSLs in the same surface soil sample (596SB006). This sample, which was collected from inside Building 101, accounted for the site's maximum number of soil detections at 15 PAHs plus dibenzofuran (26,000 μg/kg).

Dibenzofuran has no established generic SSL, accepted values of K_d , or Henry's law constant with which to calculate an SSL. Benzo(a)anthracene also exceeded its groundwater protection SSL in the subsurface soil sample from the same soil boring.

Benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected at concentrations exceeding their respective SSLs in another surface soil sample (596SB013), although concentrations at this location were much lower than at 596SB006. N-Nitroso-di-n-propylamine and isophorone were detected at concentrations exceeding their groundwater protection SSLs in one subsurface soil sample (596SB005). No organic compound, however, was detected in first-quarter groundwater samples at AOC 596, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

Four inorganics — arsenic, cobalt, copper, and selenium — were detected in AOC 596 soil at concentrations exceeding their generic SSLs and/or background reference values. Arsenic and copper exceeded their respective background reference values in the same surface soil sample (596SB006). Arsenic also exceeded its background value in one subsurface soil sample (596SB010). Cobalt exceeded its background reference value in three surface soil samples (596SB002, 596SB007, and 596SB012). Selenium exceeded its generic SSL in three subsurface soil samples (596SB003, 596SB010, and 596SB011). Of the inorganics soil exceedances, only arsenic was detected in first-quarter groundwater samples, including one deep sample with a concentration exceeding groundwater and surface water standards.

10.45.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.45.5.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared

to the greater of (a) risk-based drinking water concentrations, or (b) background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

The surficial aquifer is protected in the vicinity of AOC 596 by a thick layer of clay at or just below the surface. The well boring log of deep well NBCE59601D indicates over 14 feet of clay overlying the first saturated aquifer material, which is silt. The boring log for deep well NBCE59604D indicates one foot of saturated sand above 11 feet of clay, which overlies the silt aquifer. No organic compounds were detected in AOC 596 first-quarter groundwater samples at concentrations exceeding tap water RBCs or saltwater surface water chronic screening levels.

Arsenic's maximum detected concentration of 43.8 μg/L exceeded its background reference value for groundwater of 18.7 μg/L and its saltwater surface water chronic screening level of 36 μg/L in the groundwater sample collected from deep well NBCE59601D; however, the maximum detected concentration of arsenic was below its respective MCL of 50 μg/L. Arsenic was not detected in first-round or second-round samples from deep supplemental well NBCEGDE05D, approximately 270 feet downgradient from well NBCE59601D. Arsenic was detected in the third and fourth rounds from this well at low concentrations (4 μg/L and 5 μg/L, respectively). No other inorganics in groundwater samples were detected at concentrations exceeding first-tier screening criteria.

10.45.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.45.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil

constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 596 is 132,000:1 (see Table 6.2.1).

Except for N-nitroso-di-n-propylamine, none of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that most site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River. N-Nitroso-di-n-propylamine was detected in a single subsurface soil sample (596SB005) at a concentration of 500 μg/kg, exceeding its adjusted second-tier SSL of 317 μg/kg; however, it was not detected in groundwater samples from any of the four sampling rounds.

10.45.5.4 Soil-to-Air Cross-Media Transport

Table 10.45.5.3 lists the VOCs detected in surface soil samples collected at AOC 596 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed near AOC 596. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 596.

10.45.5.5 Fate and Transport Summary

Of the thirteen organic and inorganic constituents identified in soil at concentrations exceeding groundwater protection SSLs and/or background reference values, only arsenic was also detected in groundwater. Arsenic was detected exceeding its background reference concentration in samples from one deep well in all four sampling rounds, but did not exceed its respective MCL

in any sample. Although arsenic concentrations in groundwater did exceed both of its first-tier screening criteria, arsenic was not detected at concentrations exceeding its adjusted second-tier screening level for groundwater. This indicates no threat to surface water in the Cooper River via the groundwater to surface water migration pathway.

N-Nitroso-di-n-propylamine was detected in one subsurface soil sample at a concentration exceeding the adjusted SSL of the second-tier comparisons. It was not detected in surface soil or in groundwater through four quarters of sampling. The second-tier SSL assumes sitewide soil concentrations equal to the maximum detected concentration of the constituent. Since N-nitroso-di-n-propylamine was detected in only one of 24 soil samples, and not at all in groundwater samples, the indicated threat to surface water quality in the Cooper River via the soil to groundwater to surface water migration pathway does not exist at this time. The thick clay layer overlying the surficial aquifer in the vicinity of AOC 596 makes it unlikely that significant quantities of detected soil constituents will be able to migrate downward to the aquifer.

Table 10.45.5.1
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 596
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	150	260	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	12	48	ND	ND	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	4	6	ND	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	7	ND	ND	ND	6500	1300	4.3	UG/KG	UG/L	NO	NO	NO
Methylene chloride	2	ND	ND	ND	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
Toluene	2	ND	ND	ND	6000	750	37	UG/KG	UG/L	NO	NO	NO
Xylene (total)	150	3	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	20000	280	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	2500	570	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	36000	820	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	70000	1300	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	55000	1400	ND	ND	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	58000	1300	ND	ND	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	58000	1500	ND	ND	24500	0.92	NA	UG/KG	UG/L	YES	NO	NO
Chrysene	82000	1800	ND	ND	80000	9.2	NA	UG/KG	UG/L	YES	NO	NO
Dibenzo(a,h)anthracene	18000	340	ND	ND	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	34000	810	ND	ND	7000	0.092	NA	UG/KG	UG/L	YES	NO	NO
4-Bromophenyl-phenylether	ND	230	ND	ND	718000	2100	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	210	ND	ND	ND	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	26000	490	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	130	420	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	220000	4000	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	18000	170	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
Isophorone	ND	1500	ND	ND	250	71	129	UG/KG	UG/L	YES	NO	NO
2-Methylnaphthalene	11000	270	ND	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	26000	880	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
N-Nitroso-di-n-propylamine	ND	500	ND	ND	0.025	0.0096	NA	UG/KG	UG/L	YES	NO	NO
Phenanthrene	220000	4900	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	160000	3700	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
4,4'-DDT	11	ND	NA	NA	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Heptachlor	2	ND	NA	NA	11500	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	NA	NA	0.0087	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	11300	19700	535	26.1	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	2.3	1	ND	ND	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	155	38.7	11	43.8	23.9	18.7	36	MG/KG	UG/L	YES	YES	YES
Barium	110	96.4	ND	45.1	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.87	1.3	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	1.7	0.74	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	93.1	51.3	5.3	1.1	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	97.5	12.5	ND	10.1	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	194	51.2	ND	ND	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Lead	317	65.4	ND	ND	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	184	873	ND	715	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.39	0.33	ND	0.2	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	20.3	18	ND	15.3	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	2	2.9	ND	ND	2.5	180	71	MG/KG	UG/L	YES	NO	NO
Thallium	1.1	2.3	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO

Table 10.45.5.1
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 596
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Tin	42.3	17.9	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	35.6	71.5	3.2	1.3	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	270	206	14.7	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.45.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 596
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	70000	1300	ND	ND	800	0.092	NA	0.092	1.21E+04	0.1	1.21E+05	9.72E+06	UG/KG	UG/L	NO	NO
Benzo(a)pyrene	55000	1400	ND	ND	4000	0.0092	NA	0.0092	1.21E+03	0.2	6.07E+03	2.43E+06	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	58000	1300	ND	ND	2500	0.092	NA	0.092	1.21E+04	0.1	1.21E+05	1.04E+07	UG/KG	UG/L	NO	NO
Benzo(k)fluoranthene	58000	1500	ND	ND	24500	0.92	NA	0.92	1.21E+05	1	1.21E+05	1.04E+07	UG/KG	UG/L	NO	NO
Chrysene	82000	1800	ND	ND	80000	9.2	NA	9.2	1.21E+06	10	1.21E+05	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	18000	340	ND	ND	800	0.0092	NA	0.0092	1.21E+03	0.01	1.21E+05	9.72E+06	UG/KG	UG/L	NO	NO
Indeno(1,2,3-cd)pyrene	34000	810	ND	ND	7000	0.092	NA	0.092	1.21E+04	0.1	1.21E+05	1.04E+07	UG/KG	UG/L	NO	NO
Isophorone	ND	1500	ND	ND	250	71	129	71	9.37E+06	90	1.04E+05	2.60E+06	UG/KG	UG/L	NO	NO
N-Nitroso-di-n-propylamine	ND	500	ND	ND	0.025	0.0096	NA	0.0096	1.27E+03	0.01	1.27E+05	3.17E+02	UG/KG	UG/L	YES	NO
Inorganic Compounds																
Arsenic	155	38.7	11	43.8	14.6	0.045	36	0.045	5.94E+03	50	1.19E+02	1.73E+02	MG/KG	UG/L	NO	NO
Cobalt	97.5	12.5	ND	10.1	1040	2200	NA	2200	2.90E+08	2200	1.32E+05	1.00E+06	MG/KG	UG/L	NO	NO
Copper	194	51.2	ND	ND	458	1500	2.9	2.9	3.83E+05	1300	2.94E+02	1.35E+04	MG/KG	UG/L	NO	NO
Selenium	2	2.9	ND	ND	2.5	180	71	71	9.37E+06	50	1.87E+05	4.69E+04	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 132,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.45.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 596
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	150	62000000	UG/KG	NO
2-Butanone (MEK)	12	10000	UG/KG	NO
Carbon Disulfide	4	11000	UG/KG	NO
Ethylbenzene	7	260000	UG/KG	NO
Methylene chloride	2	7000	UG/KG	NO
Toluene	2	520000	UG/KG	NO
Xylene (total)	150	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.45.6 Fixed-Point Risk Evaluation for AOC 596

10.45.6.1 Site Background and Investigative Approach

AOC 596 was a torpedo storage area located in former Building 101. Building 101 was also used as a machine shop, a storehouse for diesel parts, and a storage area for radioactive-contaminated material. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

All twelve surface soil samples collected during the AOC 596 RFI were used in the FRE. Six monitoring wells (four shallow and two deep) were installed as part of the 1995 RFI. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 596 FRE. Sections 10.45.1 and 10.45.3 contain summaries of the sampling effort for AOC 596 soil and groundwater.

10.45.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.45.6.1 provides CPSS summaries for AOC 596 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, arsenic and BEQ equivalents were identified as COPCs for AOC 596. Aluminum, beryllium, chromium, manganese, and thallium were detected in AOC 596 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE based on comparison to their background concentrations. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.45.6.2 summarizes the residential COPCs detected at each AOC 596 sample location with contribution to risk and hazard. As shown, arsenic and BEQ equivalent compounds contribute to risk for AOC 596 surface soil, exceeding 1E-06 at all 12 locations. The highest concentrations of BEQ equivalents were reported in surface soil sample 596SB006 and 596SB013,

which were associated with risks of 7E-05 and 1E-03, respectively. Figure 10.45.3 is a spatial presentation of residential risk estimates for AOC 596 surface soil. Risk estimates range from 2E-05 to 2E-03 with an arithmetic mean risk of 2E-04.

The arsenic concentration reported in sample 596SB006 equates with a hazard quotient of 7. No other soil sample was associated with HI projections above unity. Figure 10.45.4 is a spatial presentations of residential HI projections for AOC 596 surface soil. HI projections ranged from 0.2 to 7, with an arithmetic mean HI of 0.9.

Industrial Scenario

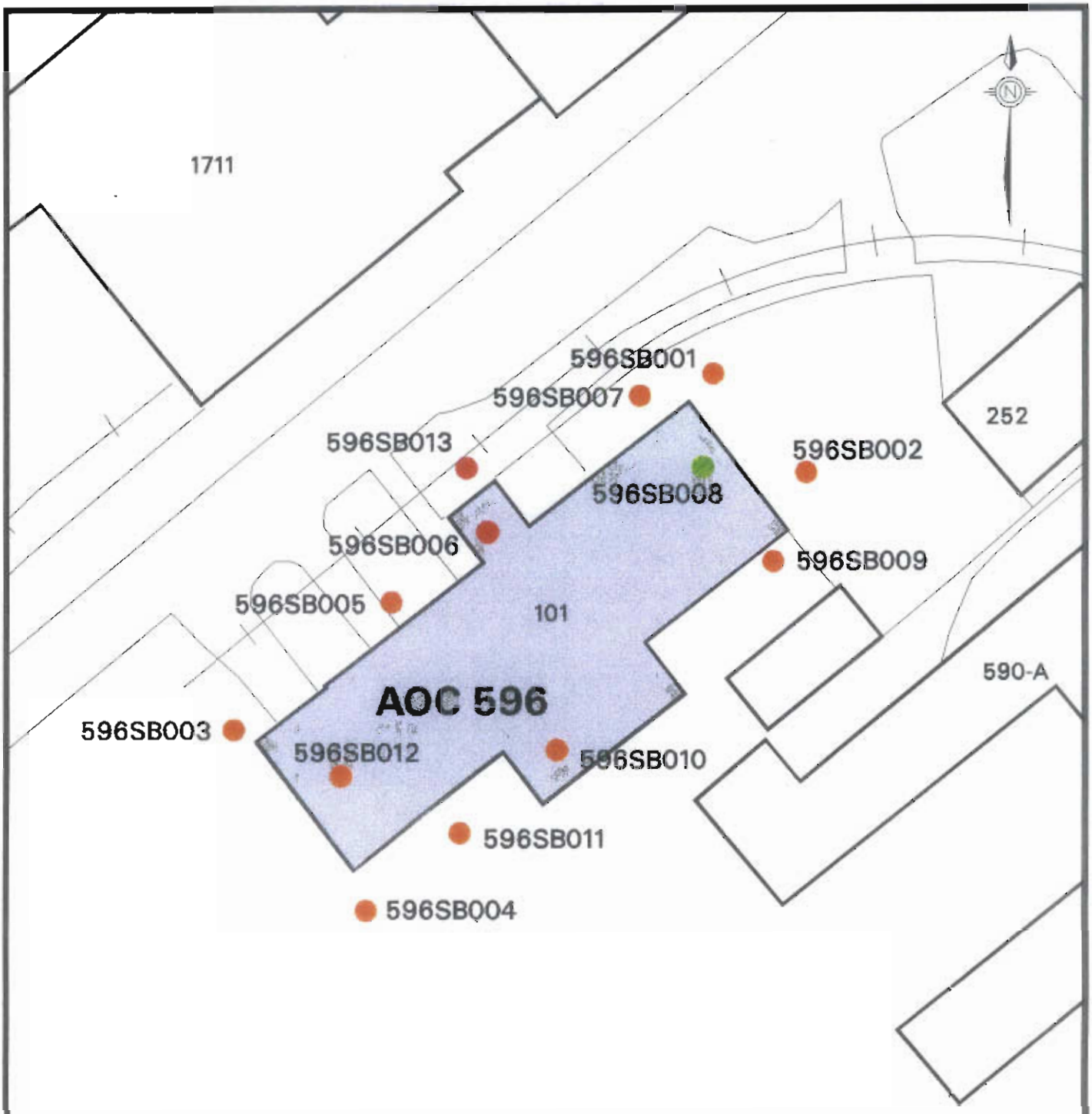
Based on industrial RBCs, arsenic and BEQ equivalents were identified as COPCs for AOC 596 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.45.6.3 summarizes the industrial COPCs detected at each AOC 596 sample location with contribution to risk and hazard. As shown, arsenic and BEQ equivalent compounds contribute to risk for AOC 596 surface soil, exceeding 1E-06 at all 12 locations. Figure 10.45.5 is a spatial presentation of industrial risk estimates for AOC 596 surface soil. Risk estimates range from 2E-06 to 4E-04 with an arithmetic mean risk of 3E-05.

No surface soil sample was associated with HI projections above unity based on the industrial scenario. HI projections ranged from 0.01 to 0.4.

10.45.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.45.6.4 provides CPSS summaries for AOC 596 groundwater and identifies COPCs. Arsenic was identified as a groundwater COPC for the deep aquifer. No COPCs were identified for the shallow aquifer. COPC identification was based on comparison of first quarter



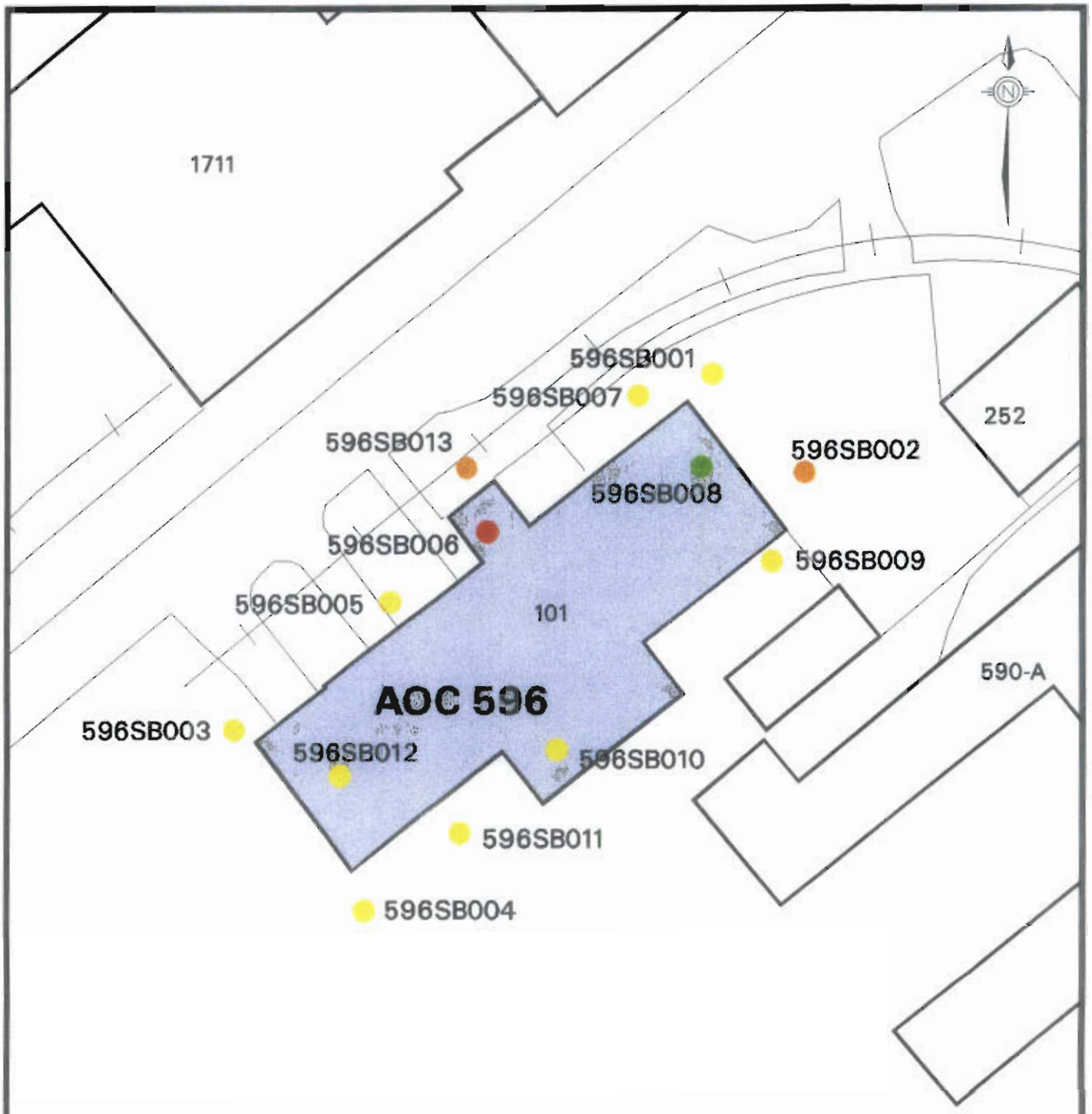
LEGEND - CUMULATIVE SOIL RISK

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 100

ZONE E - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 596



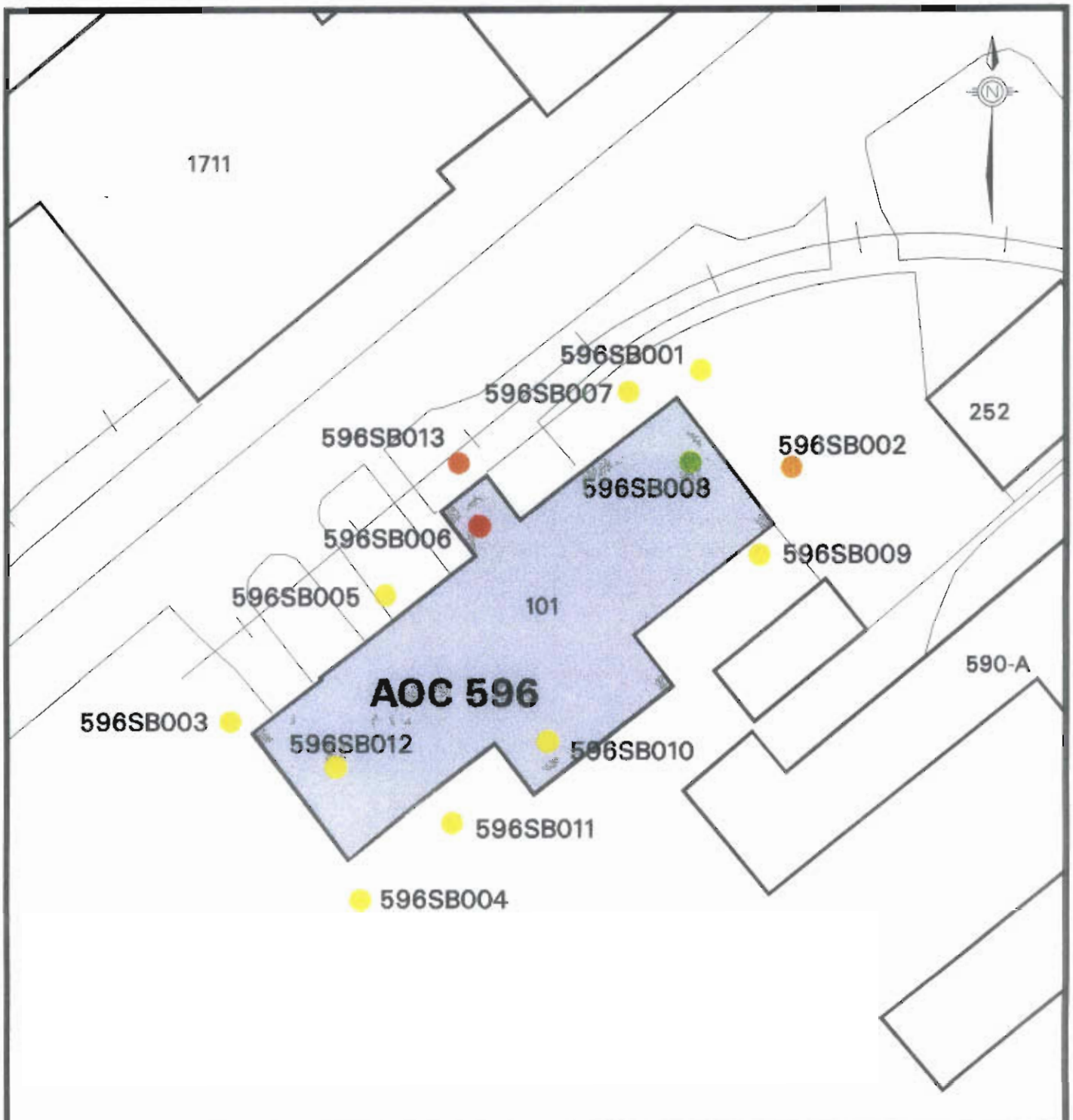
LEGEND - CUMULATIVE SOIL HAZARD

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 100

ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.4
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
AOC 596



LEGEND - CUMULATIVE SOIL RISK

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 100

ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 596

groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. The maximum concentration of arsenic reported in the shallow aquifer and the maximum concentration of manganese reported in the deep aquifer exceeded their respective RBC and were eliminated from consideration in the corresponding groundwater FRE based on comparison to their background RCs. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.45.6.5 summarizes the COPCs identified in AOC 596 monitoring wells sampled during the first quarter. Concentrations of arsenic reported for the first quarter groundwater samples collected from monitoring wells NBCE59601D and NBCE59604D equate with risks of 1E-03 and 3E-04, respectively. No COPCs were identified for the shallow aquifer based on first quarter sample results. Figure 10.45.6 illustrates the groundwater data as a function of point specific risk projections.

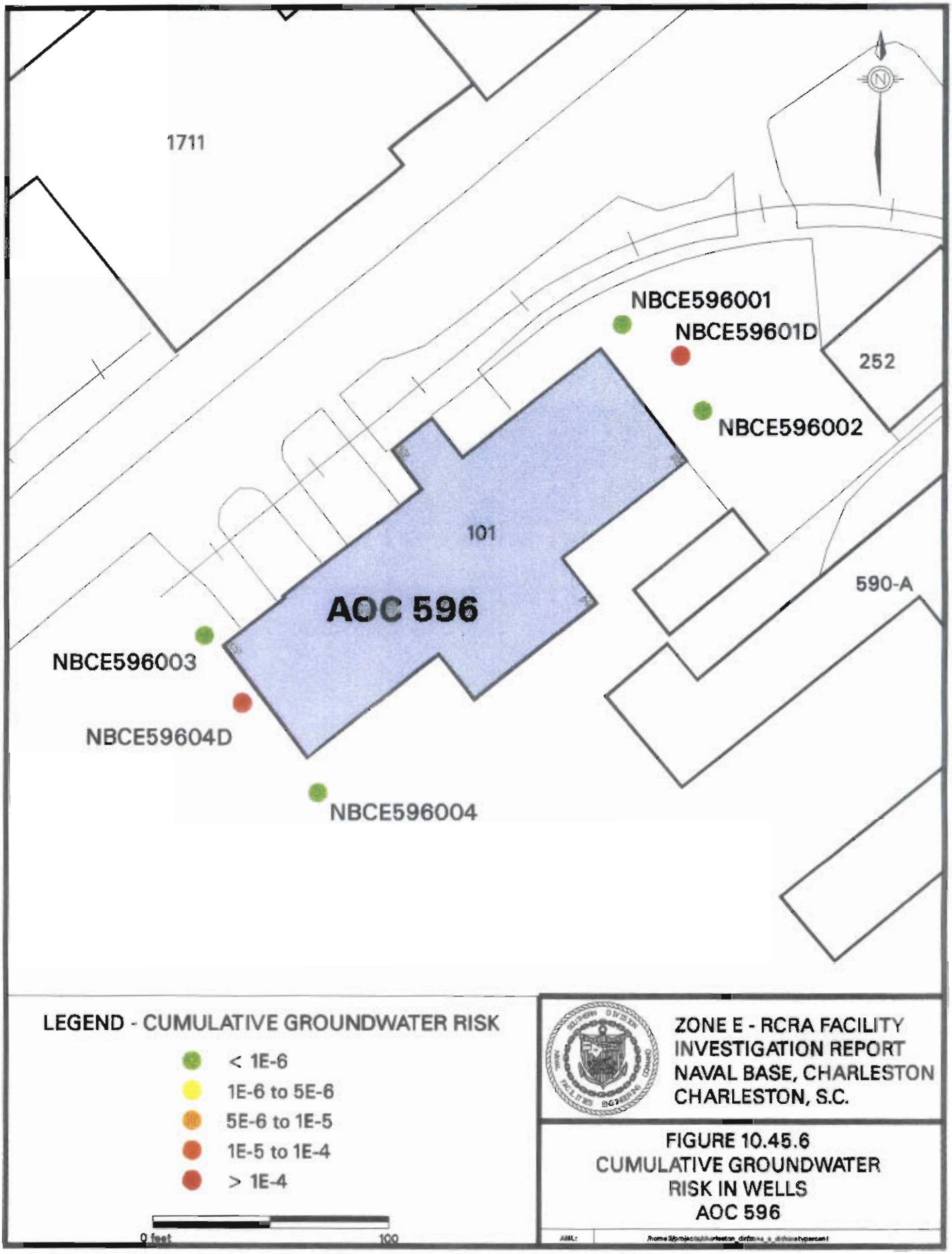
Concentrations of arsenic were associated with HI projections of 9 and 3, for groundwater samples collected from monitoring wells NBCE59601D and NBCE59602D, respectively. Figure 10.45.7 illustrates the groundwater data as a function of point specific hazard projections.

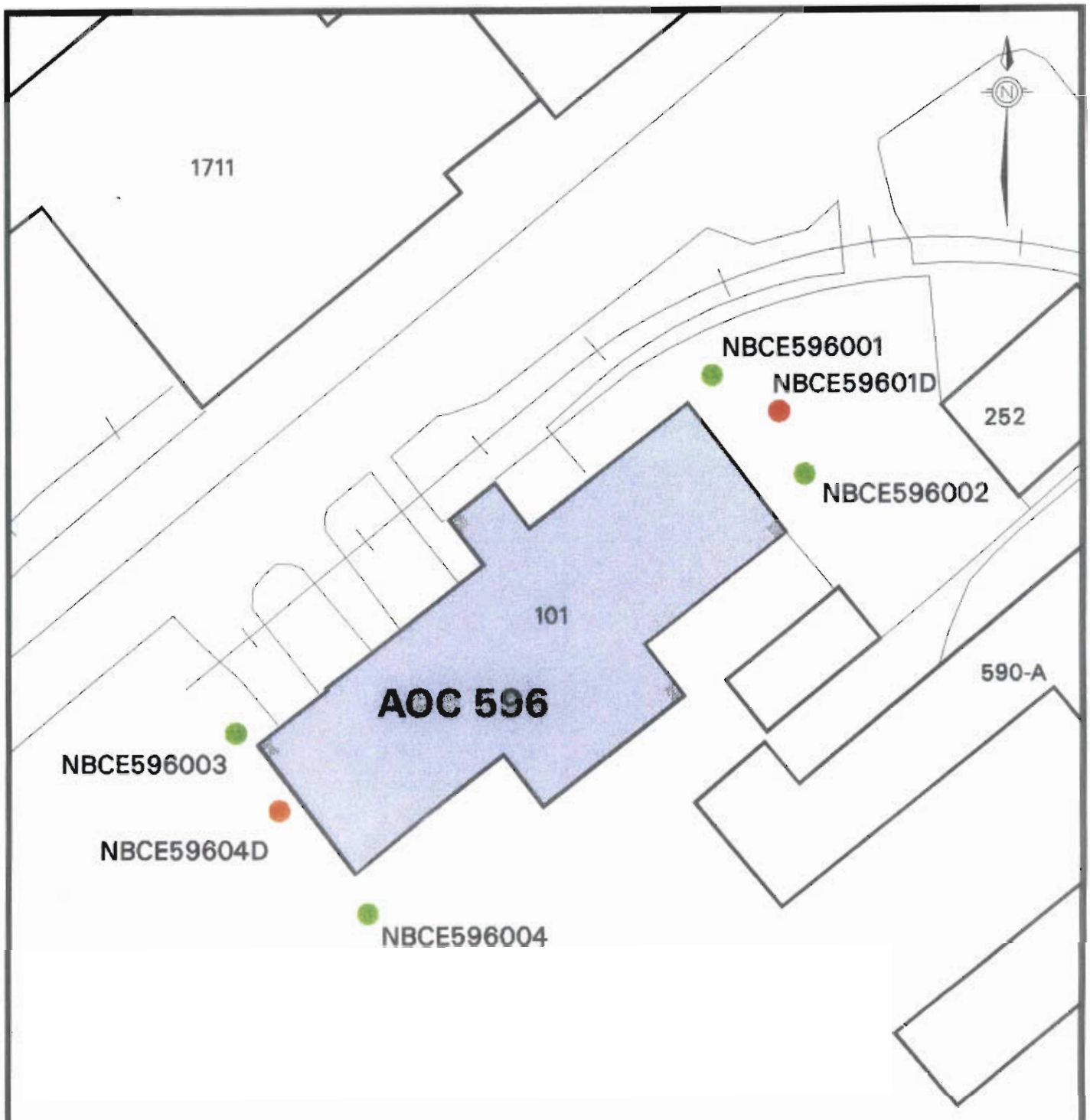
10.45.6.4 Uncertainty

AOC 596 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.


1711
NBCE596001
NBCE59601D
252
NBCE596002
101
AOC 596
590-A
NBCE596003
NBCE59604D
NBCE596004
LEGEND - CUMULATIVE GROUNDWATER RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
100
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.45.6
CUMULATIVE GROUNDWATER
RISK IN WELLS
AOC 596



LEGEND - CUMULATIVE GROUNDWATER HAZARD

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 100

ZONE E - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.45.7
CUMULATIVE GROUNDWATER HAZARD IN WELLS
AOC 596

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at AOC 596, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 596. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Aluminum, beryllium, chromium, manganese, and thallium were reported in AOC 596 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBCs (e.g., within 10% of its RBCs).

Arsenic and manganese were reported in AOC 596 shallow and deep groundwater, respectively, at a maximum concentration above their RBC benchmark and were eliminated from consideration in the FRE based on comparison to their corresponding background concentrations. As a result, their contribution to risk/hazard has not been considered in the corresponding groundwater FRE.

10.45.6.5 FRE Summary

The risk and hazard posed by contaminants at AOC 596 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.45.6.2, 10.45.6.3, and 10.45.6.4 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Arsenic was detected in AOC 596 surface soil at concentrations above its RGO in all 12 samples, however, it exceeded its background RC in only one sample. BEQ equivalent compounds were detected in AOC 596 surface soil at concentrations above their residential RGOs in seven of the 12 samples. The calculated mean risk estimate associated with BEQ equivalents was 1E-04 (assuming a deminimus risk of 1E-07 for samples which were nondetect for BEQ equivalents) which is above the 1E-06 SCDHEC risk level of concern and equal to the upper bound of USEPA's 1E-06 to 1E-04 acceptable risk range.

Soil — Site Worker Scenario

Arsenic was detected in AOC 596 surface soil at concentrations above its industrial RGO in all 12 samples, however, it exceeded its background RC in only one sample. BEQ equivalent compounds were detected in AOC 596 surface soil at concentrations above their industrial RGOs in four of the 12 samples. The calculated mean industrial risk estimate associated with BEQ equivalents was 3E-05 (assuming a deminimus risk of 1E-07 for samples which were nondetect for BEQ equivalents) which is above the 1E-06 SCDHEC risk level of concern and within USEPA's 1E-06 to 1E-04 acceptable risk range.

Groundwater — Residential Scenario

Arsenic was the primary contributor to risk and hazard projection for the deep groundwater and was detected at concentrations above its RGO in first quarter groundwater samples collected from both deep monitoring wells. Arsenic in groundwater samples collected from NBCE59601D and NBCE59602D during subsequent quarters show that its concentrations are similar to the first quarter samples. Groundwater samples collected from monitoring wells NBCE596001 and NBCE595003 during the second, third, and fourth quarters, reported higher concentrations of arsenic than those reported in the first quarter groundwater samples collected from the same wells. Arsenic was not detected at a concentration above its MCL in any AOC 596 groundwater sample

collected over four quarters. Lead (TTAL = 15 μg/L) and thallium (MCL = 2 μg/L) were both detected at concentrations above their MCLs in groundwater samples collected during subsequent quarterly sampling. Lead was detected at a concentration of 28.1 μg/L in the second quarter groundwater sample collected from monitoring well NBCE596002. Through four quarters of groundwater sampling, the only other detection of lead (1.8 μg/L) in groundwater was reported for the sample collected from monitoring well NBCE59604D during the second quarter. Thallium was detected at concentrations of 6.7 μg/L and 7.0 μg/L in fourth quarter groundwater samples collected from monitoring wells NBCE596003 and NBCE59604D, respectively. No other thallium detections were reported through four quarters of sampling.

Table 10.45.6.1
Chemicals Present in Site Samples
AOC 596 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Carcinogenic PAHs																
B(a)P Equiv.	*	*	8	12	11.11	89862	11997	1733.25	2218.56	88	780	NA	UG/KG	7	2	
Benzo(a)anthracene	*	*	7	12	100	70000	10609	750	960	880	7800	NA	UG/KG	2	1	
Benzo(b)fluoranthene	*	*	6	12	91	58000	10230	750	960	880	7800	NA	UG/KG	2	1	
Chrysene			8	12	110	82000	10949	750	960	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	*	4	12	110	18000	4790	750	960	88	780	NA	UG/KG	4	2	
Indeno(1,2,3-cd)pyrene	*	*	5	12	92	34000	7222	750	960	880	7800	NA	UG/KG	2	1	
Benzo(k)fluoranthene	*		6	12	86	58000	10331	750	960	8800	78000	NA	UG/KG	1		
Benzo(a)pyrene	*	*	7	12	91	55000	8419	750	960	88	780	NA	UG/KG	7	2	
Inorganics																
Aluminum (Al)			12	12	2070	11300	6015	NA	NA	7800	100000	26600	MG/KG	4		
Antimony (Sb)			10	12	0.48	2.3	1.49	0.48	0.5	3.1	82	1.77	MG/KG			4
Arsenic (As)	*	*	12	12	5.1	155	20.9	NA	NA	0.43	3.8	23.9	MG/KG	12	12	1
Barium (Ba)			12	12	18.8	110	41.7	NA	NA	550	14000	130	MG/KG			
Beryllium (Be)			12	12	0.29	0.87	0.48	NA	NA	0.15	1.3	1.7	MG/KG	12		
Cadmium (Cd)			11	12	0.17	1.7	0.68	0.11	0.11	3.9	100	1.5	MG/KG			1
Calcium (Ca)	N		12	12	2280	179000	37890	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)			12	12	10.6	93.1	29.4	NA	NA	39	1000	94.6	MG/KG	2		
Cobalt (Co)			12	12	1.1	97.5	14.2	NA	NA	470	12000	19	MG/KG			3
Copper (Cu)			12	12	8.7	194	43.8	NA	NA	310	8200	66	MG/KG			1
Iron (Fe)	N		12	12	4570	19300	9389	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)			12	12	25.7	317	109	NA	NA	400	1300	265	MG/KG			2
Magnesium (Mg)	N		12	12	373	5630	1983	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)			12	12	37.9	184	84.7	NA	NA	180	4700	302	MG/KG	1		
Mercury (Hg)			12	12	0.04	0.39	0.15	NA	NA	2.3	61	2.6	MG/KG			
Nickel (Ni)			12	12	3.5	20.3	10.6	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N		11	12	398	1710	1068	883	883	NA	NA	NA	MG/KG			
Selenium (Se)			9	12	0.59	2	1.10	0.59	0.65	39	1000	1.7	MG/KG			1
Sodium (Na)	N		10	12	140	1130	371.1	61.2	69.2	NA	NA	NA	MG/KG			
Thallium (Tl)			3	12	0.66	1.1	0.82	0.52	1.8	0.63	16	2.8	MG/KG	3		
Tin (Sn)			8	12	3.7	42.3	11.2	4.2	8	4700	6100	59.4	MG/KG			
Vanadium (V)			12	12	11.8	35.6	20.1	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)			12	12	29.4	270	129.7	NA	NA	2300	61000	827	MG/KG			

Table 10.45.6.1
Chemicals Present in Site Samples
AOC 596 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Pesticides														
4,4'-DDT	1	1	11	11	11	NA	NA	1900	17000	NA	UG/KG			
Heptachlor	1	1	2	2	2	NA	NA	140	1300	NA	UG/KG			
Semivolatile Organics														
Acenaphthene	2	12	1100	20000	10550	750	960	470000	12000000	NA	UG/KG			
Anthracene	2	12	210	2500	1355	750	18000	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	5	12	110	36000	7714	750	960	310000	8200000	NA	UG/KG			
bis(2-Ethylhexyl)phthalate	3	12	86	130	105.3	760	18000	46000	410000	NA	UG/KG			
Butylbenzylphthalate	1	12	210	210	210	750	18000	1600000	41000000	NA	UG/KG			
Dibenzofuran	3	12	120	26000	9003	750	960	31000	820000	NA	UG/KG			
Fluoranthene	5	12	170	220000	46322	750	960	310000	8200000	NA	UG/KG			
Fluorene	3	12	120	18000	6440	750	960	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	2	12	700	11000	5850	750	960	310000	8200000	NA	UG/KG			
Naphthalene	3	12	120	26000	8940	750	960	310000	8200000	NA	UG/KG			
Phenanthrene	6	12	96	220000	38521	750	960	310000	8200000	NA	UG/KG			
Pyrene	8	12	140	160000	21171	750	960	230000	6100000	NA	UG/KG			
Volatile Organics														
Acetone	1	12	150	150	150	11	130	780000	20000000	NA	UG/KG			
2-Butanone	3	12	6	12	9.33	11	14	4700000	100000000	NA	UG/KG			
Carbon disulfide	3	12	2	4	2.67	6	7	780000	20000000	NA	UG/KG			
Ethylbenzene	1	12	7	7	7	6	7	780000	20000000	NA	UG/KG			
Methylene chloride	1	12	2	2	2	6	48	85000	760000	NA	UG/KG			
Toluene	2	12	1	2	1.5	6	7	1600000	41000000	NA	UG/KG			
Xylene (Total)	1	12	150	150	150	6	7	16000000	100000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.45.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 596
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
596	B001	Arsenic (As)	7.70	MG/KG	0.3520	100.00	20.1124	100.00
596	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.3520		20.1124	
596	B002	Arsenic (As)	13.00	MG/KG	0.5942	100.00	33.9560	72.87
596	B002	B(a)P Equiv.	763.24	UG/KG	NA		12.6395	27.13
		Total			0.5942		46.5955	
596	B003	Arsenic (As)	5.70	MG/KG	0.2605	100.00	14.8884	85.64
596	B003	B(a)P Equiv.	150.73	UG/KG	NA		2.4961	14.36
		Total			0.2605		17.3845	
596	B004	Arsenic (As)	5.10	MG/KG	0.2331	100.00	13.3212	85.82
596	B004	B(a)P Equiv.	132.92	UG/KG	NA		2.2012	14.18
		Total			0.2331		15.5224	
596	B005	Arsenic (As)	6.90	MG/KG	0.3154	100.00	18.0228	68.94
596	B005	B(a)P Equiv.	490.26	UG/KG	NA		8.1189	31.06
		Total			0.3154		26.1417	
596	B006	Arsenic (As)	155.00	MG/KG	7.0847	100.00	404.8602	21.39
596	B006	B(a)P Equiv.	89862.00	UG/KG	NA		1488.1428	78.61
		Total			7.0847		1893.0030	
596	B007	Arsenic (As)	7.20	MG/KG	0.3291	100.00	18.8064	99.03
596	B007	B(a)P Equiv.	11.11	UG/KG	NA		0.1840	0.97
		Total			0.3291		18.9904	
596	B009	Arsenic (As)	8.00	MG/KG	0.3657	100.00	20.8960	91.91
596	B009	B(a)P Equiv.	111.09	UG/KG	NA		1.8397	8.09
		Total			0.3657		22.7357	
596	B010	Arsenic (As)	10.10	MG/KG	0.4616	100.00	26.3812	100.00
596	B010	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.4616		26.3812	
596	B011	Arsenic (As)	10.30	MG/KG	0.4708	100.00	26.9036	100.00
596	B011	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.4708		26.9036	
596	B012	Arsenic (As)	7.10	MG/KG	0.3245	100.00	18.5452	100.00
596	B012	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.3245		18.5452	
596	B013	Arsenic (As)	14.20	MG/KG	0.6491	100.00	37.0904	33.47
596	B013	B(a)P Equiv.	4452.20	UG/KG	NA		73.7298	66.53
		Total			0.6491		110.8202	

Table 10.45.6.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 596
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
596	B001	Arsenic (As)	7.70	MG/KG	0.0177	100.00	2.8452	100.00
596	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0177		2.8452	
596	B002	Arsenic (As)	13.00	MG/KG	0.0299	100.00	4.8036	65.15
596	B002	B(a)P Equiv.	763.24	UG/KG	NA		2.5699	34.85
		Total			0.0299		7.3735	
596	B003	Arsenic (As)	5.70	MG/KG	0.0131	100.00	2.1062	80.58
596	B003	B(a)P Equiv.	150.73	UG/KG	NA		0.5075	19.42
		Total			0.0131		2.6137	
596	B004	Arsenic (As)	5.10	MG/KG	0.0117	100.00	1.8845	80.81
596	B004	B(a)P Equiv.	132.92	UG/KG	NA		0.4476	19.19
		Total			0.0117		2.3320	
596	B005	Arsenic (As)	6.90	MG/KG	0.0159	100.00	2.5496	60.70
596	B005	B(a)P Equiv.	490.26	UG/KG	NA		1.6508	39.30
		Total			0.0159		4.2004	
596	B006	Arsenic (As)	155.00	MG/KG	0.3564	100.00	57.2736	15.92
596	B006	B(a)P Equiv.	89862.00	UG/KG	NA		302.5779	84.08
		Total			0.3564		359.8515	
596	B007	Arsenic (As)	7.20	MG/KG	0.0166	100.00	2.6605	98.61
596	B007	B(a)P Equiv.	11.11	UG/KG	NA		0.0374	1.39
		Total			0.0166		2.6979	
596	B009	Arsenic (As)	8.00	MG/KG	0.0184	100.00	2.9561	88.77
596	B009	B(a)P Equiv.	111.09	UG/KG	NA		0.3741	11.23
		Total			0.0184		3.3301	
596	B010	Arsenic (As)	10.10	MG/KG	0.0232	100.00	3.7320	100.00
596	B010	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0232		3.7320	
596	B011	Arsenic (As)	10.30	MG/KG	0.0237	100.00	3.8059	100.00
596	B011	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0237		3.8059	
596	B012	Arsenic (As)	7.10	MG/KG	0.0163	100.00	2.6235	100.00
596	B012	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0163		2.6235	
596	B013	Arsenic (As)	14.20	MG/KG	0.0326	100.00	5.2470	25.93
596	B013	B(a)P Equiv.	4452.20	UG/KG	NA		14.9912	74.07
		Total			0.0326		20.2382	

Table 10.45.6.4
Chemicals Present in Site Samples
AOC 596 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
Deep Wells													
Inorganics													
Aluminum (Al)		1	2	26.1	26.1	26.1	25	25	3700	319	UG/L		
Arsenic (As)	*	2	2	13.5	43.8	28.65	NA	NA	0.045	16.4	UG/L	2	1
Barium (Ba)		2	2	32.5	45.1	38.8	NA	NA	260	218	UG/L		
Calcium (Ca)	N	2	2	174000	177000	175500	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	2	1.1	1.1	1.1	1	1	18	15.5	UG/L		
Cobalt (Co)		2	2	5.9	10.1	8	NA	NA	220	12.9	UG/L		
Iron (Fe)	N	2	2	3200	8170	5685	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	173000	216000	194500	NA	NA	NA	NA	UG/L		
Manganese (Mn)		2	2	356	715	535.5	NA	NA	84	869	UG/L	2	
Mercury (Hg)		2	2	0.2	0.2	0.2	NA	NA	1.1	0.2	UG/L		
Nickel (Ni)		2	2	13.3	15.3	14.3	NA	NA	73	42.2	UG/L		
Potassium (K)	N	2	2	18100	35800	26950	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	2	2	1860000	1940000	1900000	NA	NA	NA	NA	UG/L		
Vanadium (V)		2	2	1.1	1.3	1.2	NA	NA	26	5.3	UG/L		
Shallow Wells													
TCDD Equivalents													
Dioxin Equiv.		1	1	0.0087	0.0087	0.0087	NA	NA	0.43	NA	PG/L		
Inorganics													
Aluminum (Al)		4	4	229	535	336	NA	NA	3700	2810	UG/L		
Arsenic (As)		2	4	7.6	11	9.3	5	5	0.045	18.7	UG/L	2	
Chromium (Cr)		1	4	5.3	5.3	5.3	1	1	18	12.3	UG/L		
Iron (Fe)	N	1	4	11000	11000	11000	1040	6230	NA	NA	UG/L		
Vanadium (V)		2	4	1	3.2	2.1	1	1	26	11.4	UG/L		
Zinc (Zn)		3	4	10.5	14.7	12.03	10	10	1100	27.3	UG/L		

Notes:
* - Identified as a COPC
N - Essential nutrient
UG/L - micrograms per liter
PG/L - picograms per liter
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.45.6.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 596
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
596	G01D	Arsenic (As)	43.80	UG/L	977.1429	100.00	9.3333	100.00
		Total			977.1429		9.3333	
596	G04D	Arsenic (As)	13.50	UG/L	301.1742	100.00	2.8767	100.00
		Total			301.1742		2.8767	
596	G001	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
596	G002	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
596	G003	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
596	G004	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	

10.45.7 Corrective Measures Considerations

For AOC 596, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval and deep groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is mostly paved with asphalt. Five of 12 soil samples were collected from beneath the asphalt pavement and one was collected beneath concrete.

Arsenic and BEQs were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 2E-04 and the arithmetic mean HI is 0.9. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI. Arsenic was detected in all 12 soil samples above its RGO and BEQs were detected above their RGOs in four soil samples. Residential risk-based remedial goals for surface soil set for arsenic and BEQs are 0.38 and 0.06 based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.45.7.1.

Arsenic was identified in the deep groundwater at concentrations that equal a risk above 1E-06 and/or an HI above 1. The RGO for arsenic in groundwater is 0.000045 mg/L. Lead was detected above its TTAL of 15 μg/L (NBCE596002, 28.1 μg/L) during the second round of sampling and thallium was identified above its MCL in shallow and deep groundwater during the fourth quarterly sampling event. Potential corrective measures for the deep groundwater, in addition to no further action, are presented in Table 10.45.7.1. Corrective measures for AOC 596 are detailed in Section 9.

Table 10.45.7.1
Potential Corrective Measures for AOC 596

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic and BEQs	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste
Shallow Groundwater	Arsenic and lead	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment
Deep Groundwater	Arsenic and thallium	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.46 AOC 597, Substation, Building 91

AOC 597 is an electrical substation located in Building 91. Built in 1942, it has served as a substation since construction. Two additional transformers are housed inside the building along with several high-voltage switches, breakers, and a battery bank which provides emergency power for the building. Several weatherproof metal enclosures which house two transformers are located adjacent to Building 91.

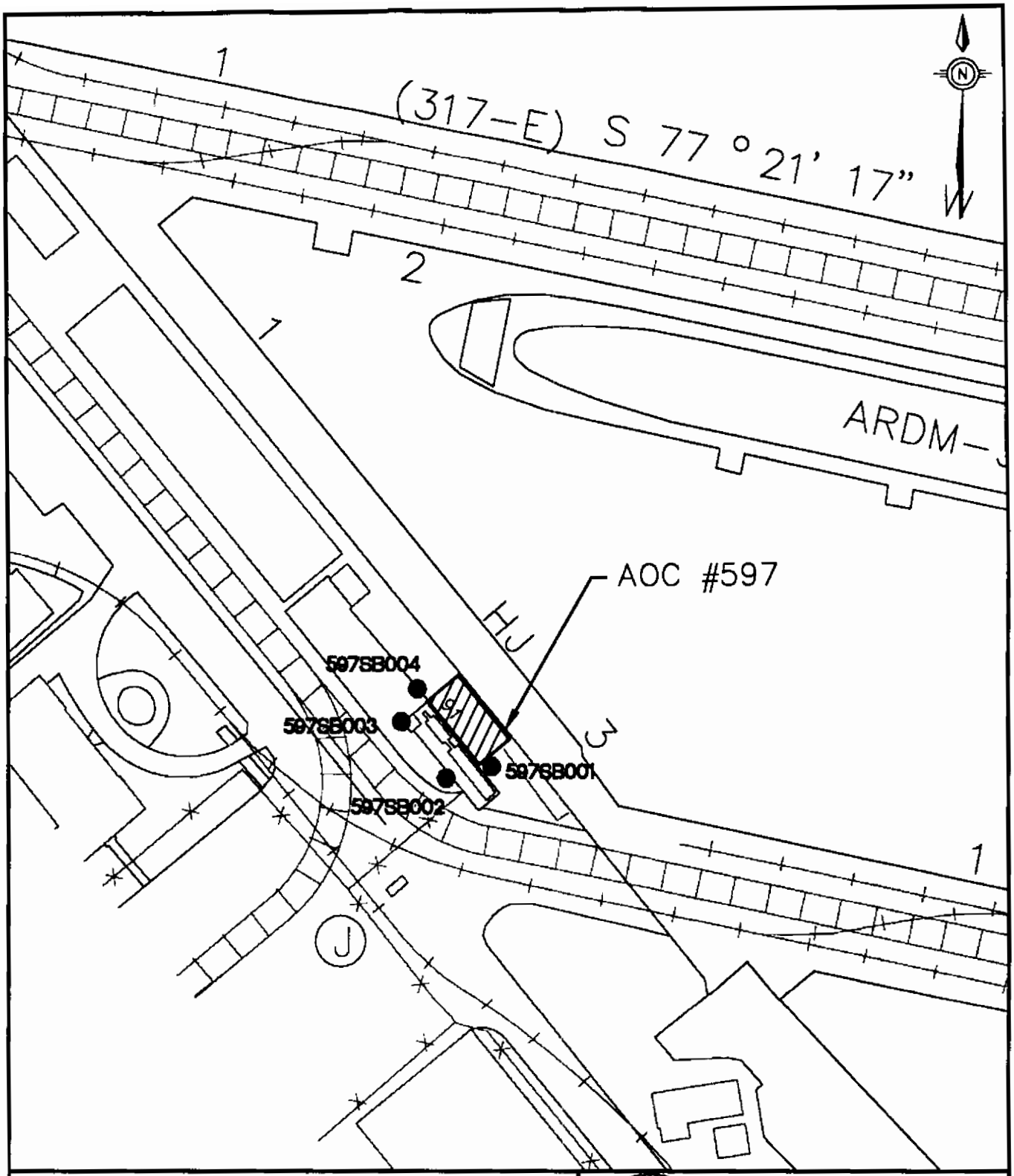
This site has not been investigated previously, but minor leaks in a transformer were reported in 1981 and 1982. A PCB audit conducted in 1985 found a moderate leak from the same transformer. The transformer was removed and disposed of in 1989. During the RFA, oil stains were visible in the building in the area of the transformer.

Materials of concern identified in the *Final Zone E RFI Work Plan* include dielectric fluid and lead/acid batteries. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 597, soil, concrete core, and concrete surface wipe samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.46.1 Soil Sampling and Analysis

Soil was sampled in one round at AOC 597 from the locations shown in Figure 10.46.1. The *Final Zone E RFI Work Plan*, proposed collecting four soil samples from the upper interval and four samples from the lower interval. All four proposed upper- and lower-interval samples were collected.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- Ⓐ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.46.1
SOIL BORING LOCATIONS
AOC #597
SUBSTATION
BUILDING 91

DWG DATE: 09/02/97 | DWG NAME: 10-46-1

All samples were submitted for analysis at DQO Level III for pH, metals, and PCBs. One upperinterval sample was selected for duplication and analyzed for Appendix IX analytical which includes the suite of parameters proposed for the site, plus herbicides, organophosphorus pesticides, hexavalent chromium, and dioxins at DQO Level IV. Table 10.46.1.1 summarizes soil sampling at AOC 597.

Table 10.46.1.1
AOC 597
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	pH, metals, PCBs	pH, metals, PCBs	None
Lower	4	4	pH, metals, PCBs	pH, metals, PCBs	None

10.46.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.46.2.1. Inorganic analytical results for soil are summarized in Table 10.46.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.46.2.1
AOC 597
Organic Compounds Detected in Soil

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides/PCBs (µg/kg)						
Aroclor-1248	Upper	3/4	63.0 - 1,600	648	740	1
	Lower	2/4	71.0 - 140	106	NA	NA
Aroclor-1254	Upper	1/4	1,600	1,600	740	1
Aroclor-1260	Upper	3/4	190 - 340	241	740	0
	Lower	1/4	130	130	NA	NA

Table 10.46.2.1
AOC 597
Organic Compounds Detected in Soil

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	1/1	5.46	5.46	1,000	0
1234678-HpCDD	Upper	1/1	93.3	93.3	NA	NA
1234678-HpCDF	Upper	1/1	38.5	38.5	NA	NA
123678-HxCDD	Upper	1/1	3.46	3.46	NA	NA
123678-HxCDF	Upper	1/1	8.81	8.81	NA	NA
234678-HxCDF	Upper	1/1	1.54	1.54	NA	NA
OCDD	Upper	1/1	872	872	NA	NA
OCDF	Upper	1/1	117	117	NA	NA
23478-PeCDF	Upper	1/1	1.66	1.66	NA	NA
2378-TCDF	Upper	1/1	9.42	9.42	NA	NA

Notes:
µg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.46.2.2
AOC 597
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Aluminum (Al)	Upper	4/4	1,600 - 4,150	2,900	100,000	26,600	0
	Lower	4/4	1,010 - 5,510	3,370	NA	41,100	NA
Antimony (Sb)	Upper	4/4	1.60 - 4.30	2.60	82.0	1.77	0
	Lower	3/4	0.560 - 4.70	1.99	NA	1.60	NA

Table 10.46.2.2
AOC 597
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Arsenic (As)	Upper	4/4	0.640 - 49.3	22.0	3.80	23.9	2
	Lower	4/4	0.770 - 7.50	4.39	NA	19.9	NA
Barium (Ba)	Upper	4/4	6.30 - 41.1	29.1	14,000	130	0
	Lower	4/4	4.70 - 36.8	16.0	NA	94.1	NA
Beryllium (Be)	Upper	4/4	0.110 - 0.470	0.303	1.30	1.70	0
	Lower	2/4	0.280 - 0.490	0.385	NA	2.71	NA
Cadmium (Cd)	Upper	4/4	0.140 - 0.950	0.490	100	1.50	0
	Lower	3/4	0.160 - 0.200	0.177	NA	0.960	NA
Calcium (Ca)	Upper	4/4	652 - 7,470	4,540	NA	NA	NA
	Lower	4/4	663 - 12,100	5,100	NA	NA	NA
Chromium (Cr)	Upper	4/4	4.50 - 22.1	16.5	1,000	94.6	0
	Lower	4/4	3.20 - 11.7	7.80	NA	75.2	NA
Cobalt (Co)	Upper	4/4	0.390 - 7.50	3.40	12,000	19.0	0
	Lower	3/4	0.380 - 1.90	1.19	NA	14.9	NA
Copper (Cu)	Upper	4/4	7.60 - 151	62.5	8,200	66.0	0
	Lower	4/4	9.50 - 16.5	12.9	NA	152	NA
Iron (Fe)	Upper	4/4	2,060 - 11,200	6,990	61,000	NA	0
	Lower	4/4	806 - 16,200	6,460	NA	NA	NA
Lead (Pb)	Upper	4/4	38.8 - 230	134	1,300	265	0
	Lower	4/4	17.5 - 39.3	26.9	NA	173	NA
Magnesium (Mg)	Upper	4/4	73.0 - 628	381	NA	NA	NA
	Lower	4/4	36.0 - 932	481	NA	NA	NA

Table 10.46.2.2
AOC 597
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Manganese (Mn)	Upper	4/4	6.90 - 64.9	45.5	4,700	302	0
	Lower	4/4	3.50 - 48.4	25.9	NA	881	NA
Mercury (Hg)	Upper	4/4	0.0200 - 1.000	0.365	61	2.60	0
	Lower	4/4	0.0800 - 1.20	0.663	NA	1.59	NA
Nickel (Ni)	Upper	4/4	1.50 - 14.2	8.88	4,100	77.1	0
	Lower	4/4	0.850 - 4.80	3.11	NA	57.0	NA
Potassium (K)	Upper	1/4	593	593	NA	NA	NA
	Lower	2/4	942 - 1,030	986	NA	NA	NA
Selenium (Se)	Upper	2/4	0.780	0.780	1,000	1.70	0
	Lower	1/4	0.850	0.850	NA	2.40	NA
Sodium (Na)	Upper	1/4	148	148	NA	NA	NA
	Lower	1/4	387	387	NA	NA	NA
Tin (Sn)	Upper	4/4	3.10 - 13.8	8.80	100,000	59.4	0
	Lower	4/4	3.60 - 4.50	4.05	NA	9.23	NA
Vanadium (V)	Upper	4/4	3.30 - 17.5	11.6	1,400	94.3	0
	Lower	4/4	2.30 - 24.8	11.6	NA	155	NA
Zinc (Zn)	Upper	4/4	56.3 - 499	247	61,000	827	0
	Lower	4/4	30.3 - 62.4	47.4	NA	886	NA
pH (SU)							
	Upper	4/4	7.63 - 8.39	8.06	NA	NA	NA
	Lower	4/4	7.46 - 8.05	7.85	NA	NA	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established
SU = Standard Units

Pesticides and PCBs in Soil

No organophosphorus pesticides were detected in the duplicate soil sample submitted for laboratory analysis from AOC 597.

Three PCBs were detected in soil samples collected at AOC 597. Eight detections occurred in the upper interval and three in the lower interval. Two PCBs — Aroclor-1248 and Aroclor-1254 — exceeded their respective industrial RBC in the upper interval. No SSL has been established for PCBs.

Aroclor-1248 was detected in three of four upper-interval samples with a range of 63.0 to 1,600 μg/kg and a mean of 648 μg/kg. One upper-interval sample (597SB0021,600 μg/kg) exceeded the Aroclor-1248 industrial RBC of 740 μg/kg.

Aroclor-1254 was detected in one of four upper-interval samples at 1,600 μg/kg. One sample (597SB002, 1,600 μg/kg) exceeded the Aroclor-1254 industrial RBC of 740 μg/kg.

Other Organic Compounds in Soil

Nine dioxins were detected in soil samples collected at AOC 597. Nine detections occurred in the upper interval; no lower-interval samples were collected. No industrial RBCs have been established for the detected dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated. The upper-interval TEQ was calculated for one sample at 5.46 ng/kg, below the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

Twenty-two metals were detected in soil samples collected at AOC 597. Eighty detections occurred in the upper interval and 70 occurred in the lower interval. One metal — arsenic —

exceeded both its respective industrial RBC and background RC in the upper interval. No metal exceeded both its respective SSL and background RC in the lower interval.

Arsenic was detected in four of four upper-interval samples with a range of 0.640 to 49.3 mg/kg and a mean of 22.0 mg/kg. Two upper-interval samples (597SB001, 26.2 mg/kg; 597SB002, 49.3 mg/kg) exceeded both the arsenic industrial RBC of 3.8 mg/kg and the background RC of 23.9 mg/kg.

10.46.3 Wipe Sampling and Analysis

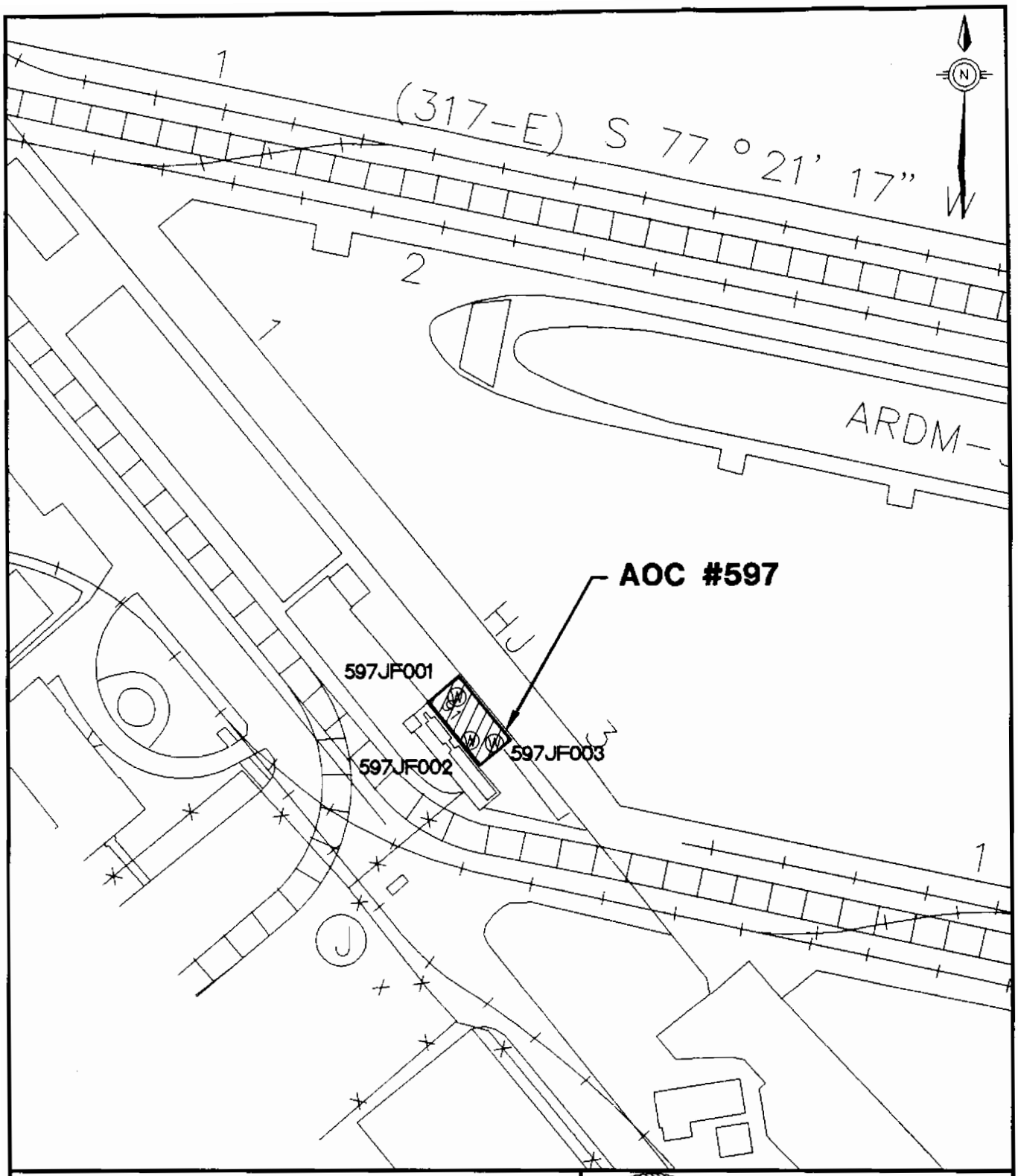
Concrete surfaces were sampled at AOC 597 from the locations shown in Figure 10.46.2. The *Final Zone E RFI Work Plan* proposed the collection of three wipe samples at AOC 597. All three samples were collected and submitted for PCB analysis. Table 10.46.3.1 summarizes wipe sampling activity for AOC 597.

Table 10.46.3.1
AOC 597
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
3	3	PCB	PCB	No deviation from proposed strategy

10.46.4 Nature of Contamination in Dust

Table 10.46.4.1 summarizes the wipe sample analytical results for AOC 597. Sample locations were determined in the field and were biased in an attempt to identify worst case situations. Sample locations were selected in the field based on the location of PCB-containing equipment and visual evidence of spills and leaks.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.46.2
WIPE SAMPLE LOCATIONS
AOC #597
SUBSTATION
BUILDING 91

DWG DATE: 09/02/97 | DWG NAME: 10-46-2

Table 10.46.4.1
AOC 597
Wipe Sampling Analytical Results

Parameter	Frequency Of Detection	Range of Detections (μg/wipe)
PCB	2/3	2.7 - 2.8

Note:
μg/wipe = Micrograms per wipe sample

PCBs Detected on Surfaces

PCBs were detected in two of three surface wipe samples with a range of 2.7 to 2.8 μg\ 100 cm^2. No residential or industrial RBCs exist for wipe samples.

10.46.5 Concrete Core Sampling and Analysis

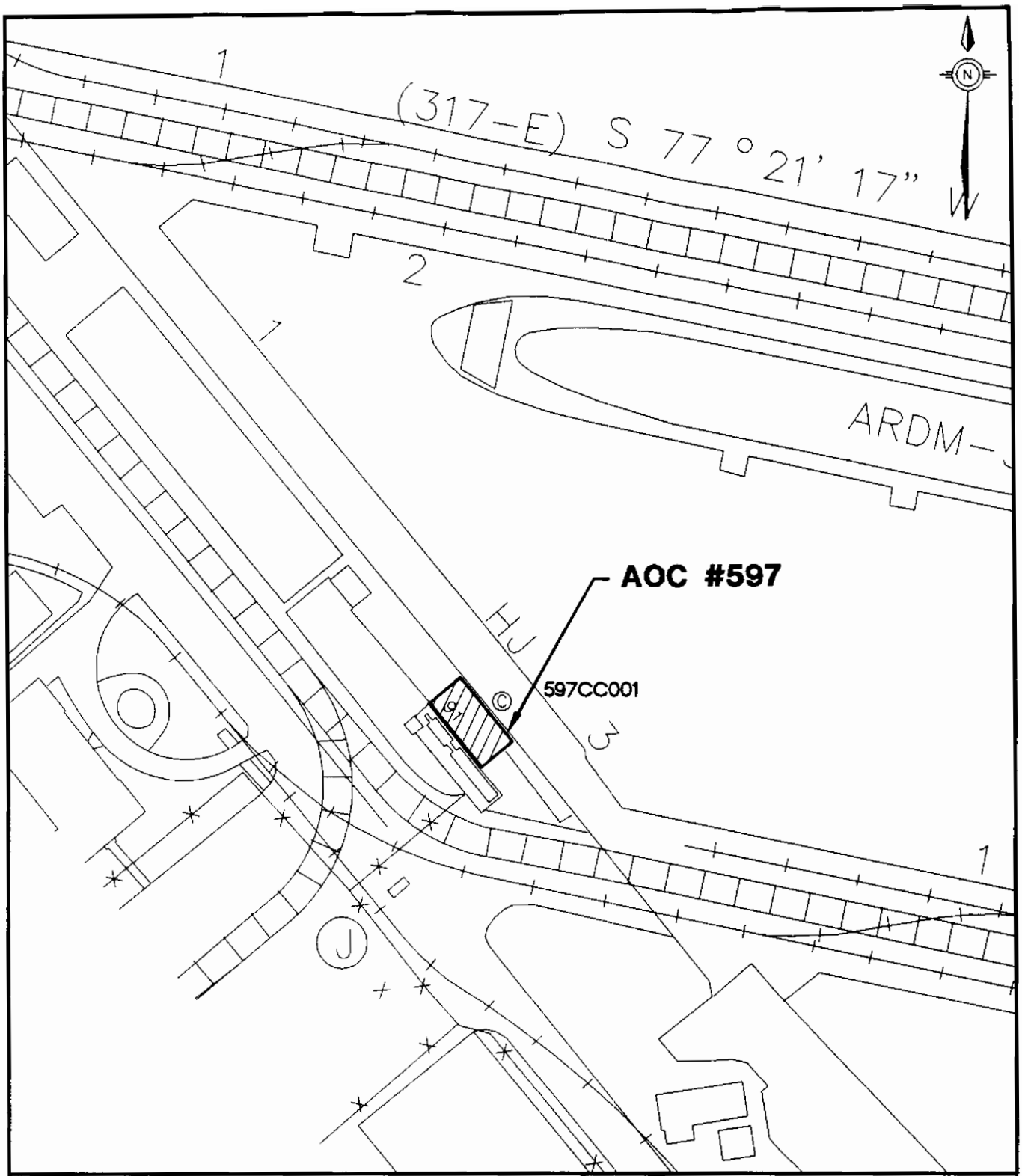
The *Final Zone E RFI Work Plan* proposed collecting one concrete core sample at AOC 597 from the location shown in Figure 10.46.3. One concrete core sample was collected and submitted for analysis at DQO Level III for PCBs, metals, and pH. No samples were selected as duplicates at this site. Table 10.46.5.1 summarizes concrete core sampling and analysis at AOC 597.

Table 10.46.5.1
AOC 597
Concrete Core Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
1	1	PCBs, metals, pH	PCBs, metals, pH	None

10.46.6 Nature of Contamination in Concrete

Inorganic analytical results for concrete are summarized in Table 10.46.6.1. Appendix H contains the complete data report for all samples collected in Zone E.



ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.46.3
CONCRETE SAMPLE LOCATIONS
AOC #597
SUBSTATION
BUILDING 91

DWG DATE: 09/02/97 | DWG NAME: 10-46-3

Table 10.46.6.1
AOC 597
Inorganics Detected in Concrete Samples

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.
Inorganic Elements (mg/kg)			
Aluminum (Al)	1/1	6,760	6,760
Arsenic (As)	1/1	4.50	4.50
Barium (Ba)	1/1	90.0	90.0
Beryllium (Be)	1/1	0.540	0.540
Cadmium (Cd)	1/1	1.10	1.10
Calcium (Ca)	1/1	63,400	63,400
Chromium (Cr)	1/1	17.6	17.6
Cobalt (Co)	1/1	2.90	2.90
Copper (Cu)	1/1	156	156
Iron (Fe)	1/1	6,030	6,030
Lead (Pb)	1/1	27.7	27.7
Magnesium (Mg)	1/1	2,240	2,240
Manganese (Mn)	1/1	86.9	86.9
Nickel (Ni)	1/1	8.30	8.30
Potassium (K)	1/1	2,150	2,150
Sodium (Na)	1/1	244	244
Vanadium (V)	1/1	18.4	18.4
Zinc (Zn)	1/1	275	275
pH (SU)			
pH	1/1	12.2 SU	12.2 SU

Notes:
mg/kg = Milligrams per kilogram
SU = Standard Units

Pesticides and PCBs in Concrete

No pesticides or PCBs were detected in concrete samples submitted for laboratory analysis at AOC 597.

Inorganic Elements in Concrete

Eighteen inorganics were detected in the concrete sample at AOC 597. No industrial RBCs exist for parameters detected in concrete samples.

pH in Concrete

The pH of the AOC 597 concrete sample was 12.2 SU. No industrial RBC has been established for pH.

10.46.7 Fate and Transport Assessment for AOC 597

AOC 597 is an electrical substation located in Building 91, next to the quaywall. Building 91 is surrounded by asphalt and concrete pavement, with the exception of two small grassy strips along the northwest and southeast sides of the building. Environmental samples included as part of the AOC 597 RFI include surface soil, subsurface soil, concrete, and wipe samples. The potential constituent migration pathway investigated for AOC 597 is soil to groundwater to surface water. The emission of volatiles from surface soil to air pathway was not assessed since no VOCs were detected in surface soil samples.

10.46.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.46.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background reference concentrations. To provide a

conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Two organic compounds — Aroclor-1248 and Aroclor-1254 — were detected in AOC 597 surface soil at concentrations exceeding generic groundwater protection SSLs. Aroclor-1248 was detected above its SSL in one surface soil sample (597SB00201) and Aroclor-1254 was detected at a concentration exceeding its SSL in a duplicate sample from the same surface soil location.

Two inorganics — antimony and arsenic — were detected in AOC 597 soil at concentrations exceeding generic groundwater protection SSLs and/or background reference values. Antimony was detected at a concentration exceeding its generic groundwater protection SSL in one surface soil sample and one subsurface soil sample from the same soil boring (597SB004). Arsenic was detected at a concentration exceeding its background reference value in two surface soil samples (597SB001 and 597SB002).

10.46.7.2 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.46.7.2 provides a second screening tier for all constituents detected in soil at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in soil are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 597 is 205,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil pose no threat to human health or the environment in the Cooper River.

10.46.7.3 Fate and Transport Summary

Aroclor-1248 and Aroclor-1254 were detected in one surface soil sample from AOC 597 at concentrations exceeding first-tier screening criteria. Antimony was detected at a concentration exceeding its generic groundwater protection SSL in one surface soil sample and one subsurface sample from the same soil boring. Arsenic was detected at a concentration that exceeded its background reference value in two surface soil samples.

No constituent exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathway.

Table 10.46.7.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 597
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Pesticides/PCB Compounds												
Aroclor-1248	1600	140	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	YES	NO	NO
Aroclor-1254	1600	ND	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	YES	NO	NO
Aroclor-1260	340	130	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	5.46	NA	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	4150	5510	NA	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	4.3	4.7	NA	NA	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	49.3	7.5	NA	NA	23.9	18.7	36	MG/KG	UG/L	YES	NO	NO
Barium	41.1	36.8	NA	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.47	0.49	NA	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.95	0.2	NA	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	22.1	11.7	NA	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	7.5	1.9	NA	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	151	16.5	NA	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	230	39.3	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	64.9	48.4	NA	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	1	1.2	NA	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	14.2	4.8	NA	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.78	0.85	NA	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Tin	13.8	4.5	NA	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	17.5	24.8	NA	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	499	62.4	NA	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.46.7.2
Chemicals Detected in Surface Soil or Subsurface Soil at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 597
Charleston, South Carolina

	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
Parameter	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Pesticides/PCB Compounds																
Aroclor-1248	1600	140	NA	NA	1000	0.0087	0.03	0.0087	1.78E+03	0.5	3.57E+03	3.57E+05	UG/KG	UG/L	NO	NO
Aroclor-1254	1600	ND	NA	NA	1000	0.0087	0.03	0.0087	1.78E+03	0.5	3.57E+03	3.57E+05	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	4.3	4.7	NA	NA	2.5	15	NA	15	3.08E+06	6	5.13E+05	1.28E+05	MG/KG	UG/L	NO	NO
Arsenic	49.3	7.5	NA	NA	14.6	0.045	36	0.045	9.23E+03	50	1.85E+02	2.69E+02	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 205,000; GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

10.46.8 Fixed-Point Risk Evaluation for AOC 597

10.46.8.1 Site Background and Investigative Approach

AOC 597 is an electrical substation located in Building 91. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment is presented as a FRE following the framework presented in Section 7.3.

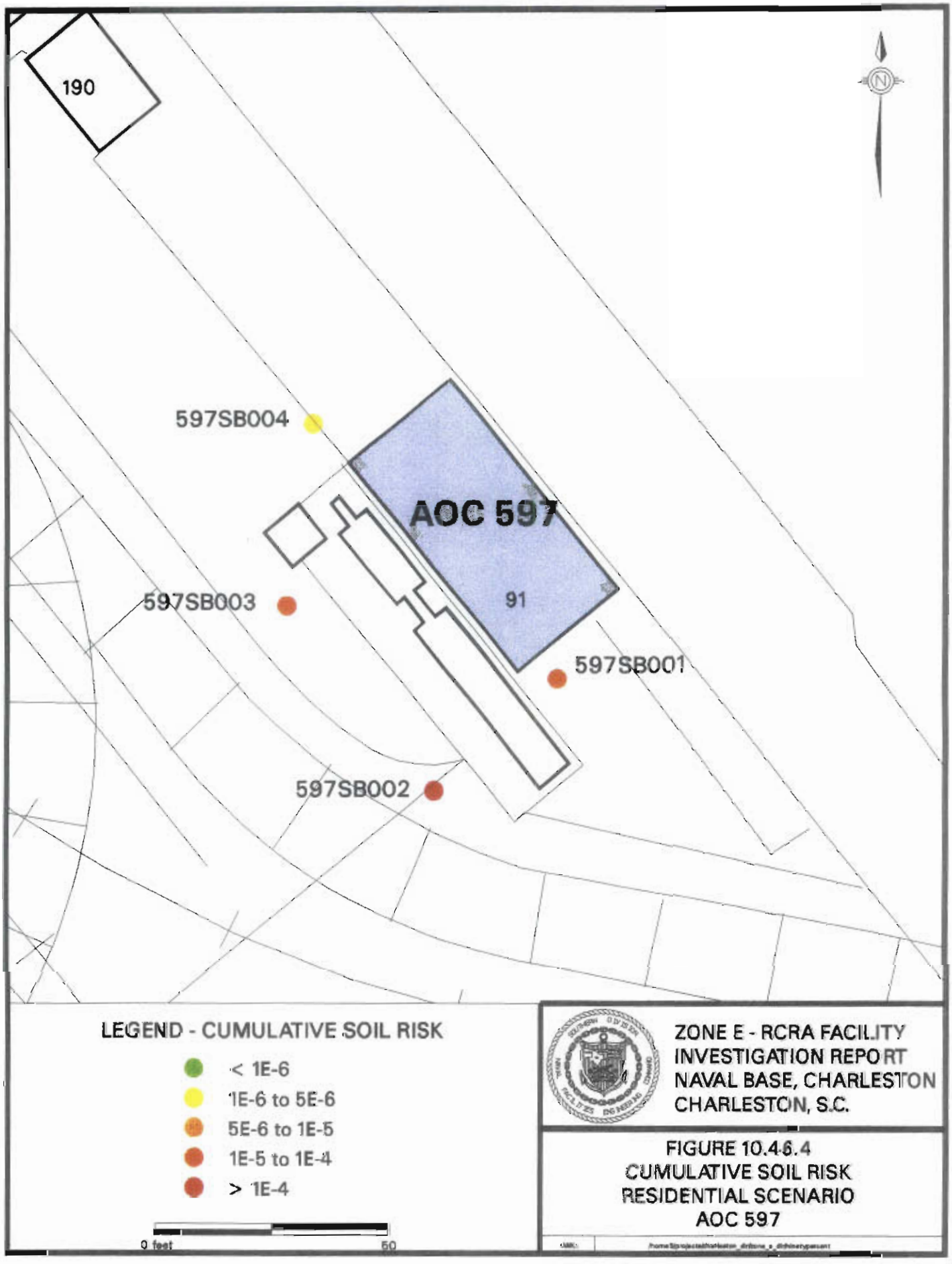
All four surface soil samples collected during the AOC 597 CSI were considered in the FRE. Groundwater investigation was not part of the CSI sampling activities for this site. Section 10.46.1 contains a summary of the soil sampling effort for AOC 597.

10.46.8.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.46.8.1 provides CPSS summaries for AOC 597 surface soil and identifies COPCs based on comparison to residential and industrial RBCs, and background RCs. Based on residential RBCs, Aroclor-1248, Aroclor-1254, Aroclor-1260, antimony, and arsenic were identified as COPCs for AOC 597. Beryllium was detected in AOC 597 surface soil at concentrations above its RBC, but was eliminated from consideration in the residential FRE based on comparison to its background concentration. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.46.8.2 summarizes the residential COPCs detected at each AOC 597 sample location with contribution to risk and hazard. As shown, Aroclor-1248, Aroclor-1254, Aroclor-1260, and arsenic contribute to risk estimates for AOC 597 surface soil, exceeding 1E-06 at all four sample locations. Figure 10.46.4 is a spatial presentation of residential risk estimates for AOC 597 surface soil. Risk estimates ranged from 3E-06 to 1E-04, with an arithmetic mean risk of 6E-05.


190
597SB004
AOC 597
91
597SB003
597SB001
597SB002
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
50
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.4.6.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 597

Antimony, Aroclor-1254, and arsenic contributed to HI estimates, which exceeded unity at two of four sample locations (597SB001 and 597SB002). Figure 10.46.5 is a spatial presentation of residential hazard estimates for AOC 597 surface soil. Hazard estimates ranged from 0.2 to 4, with an arithmetic mean hazard of 1.4.

Industrial Scenario

Based on industrial RBCs, Aroclor-1248, Aroclor-1254, and arsenic were identified as COPCs for AOC 597 surface soil.

Table 10.46.8.3 summarizes industrial COPCs detected at each AOC 597 sample location with contribution to risk and hazard. Aroclor-1248, Aroclor-1254, and arsenic contributed to industrial risk estimates for AOC 597 surface soil in three of four samples (597SB001, 597SB002, and 597SB003). Figure 10.46.6 is a spatial presentation of industrial risk estimates for AOC 597 surface soil. Risk estimates ranged from 3E-07 to 2E-05, with an arithmetic mean risk of 9E-06.

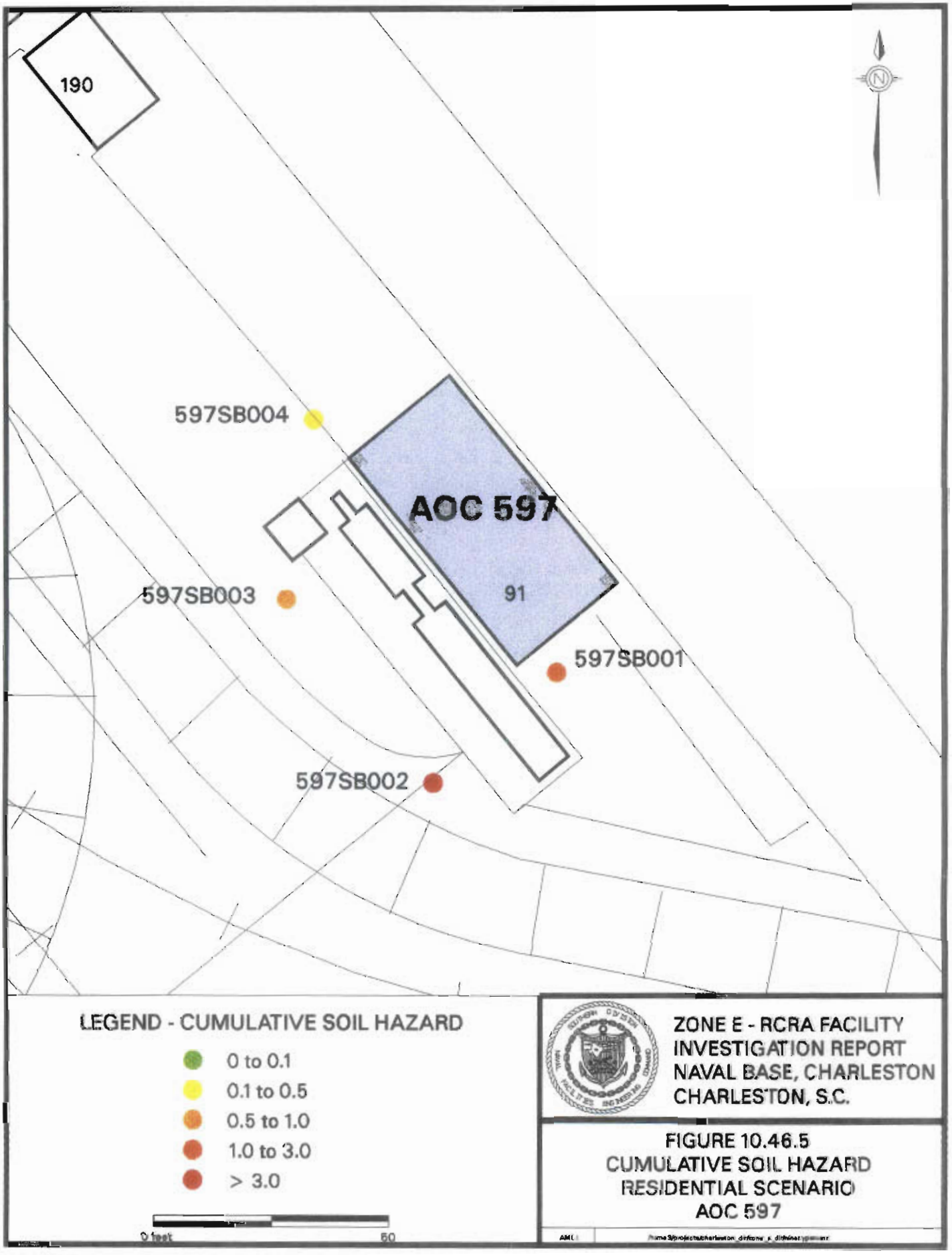
HI estimates did not exceed unity at any sample locations, and ranged from 0.002 to 0.2.

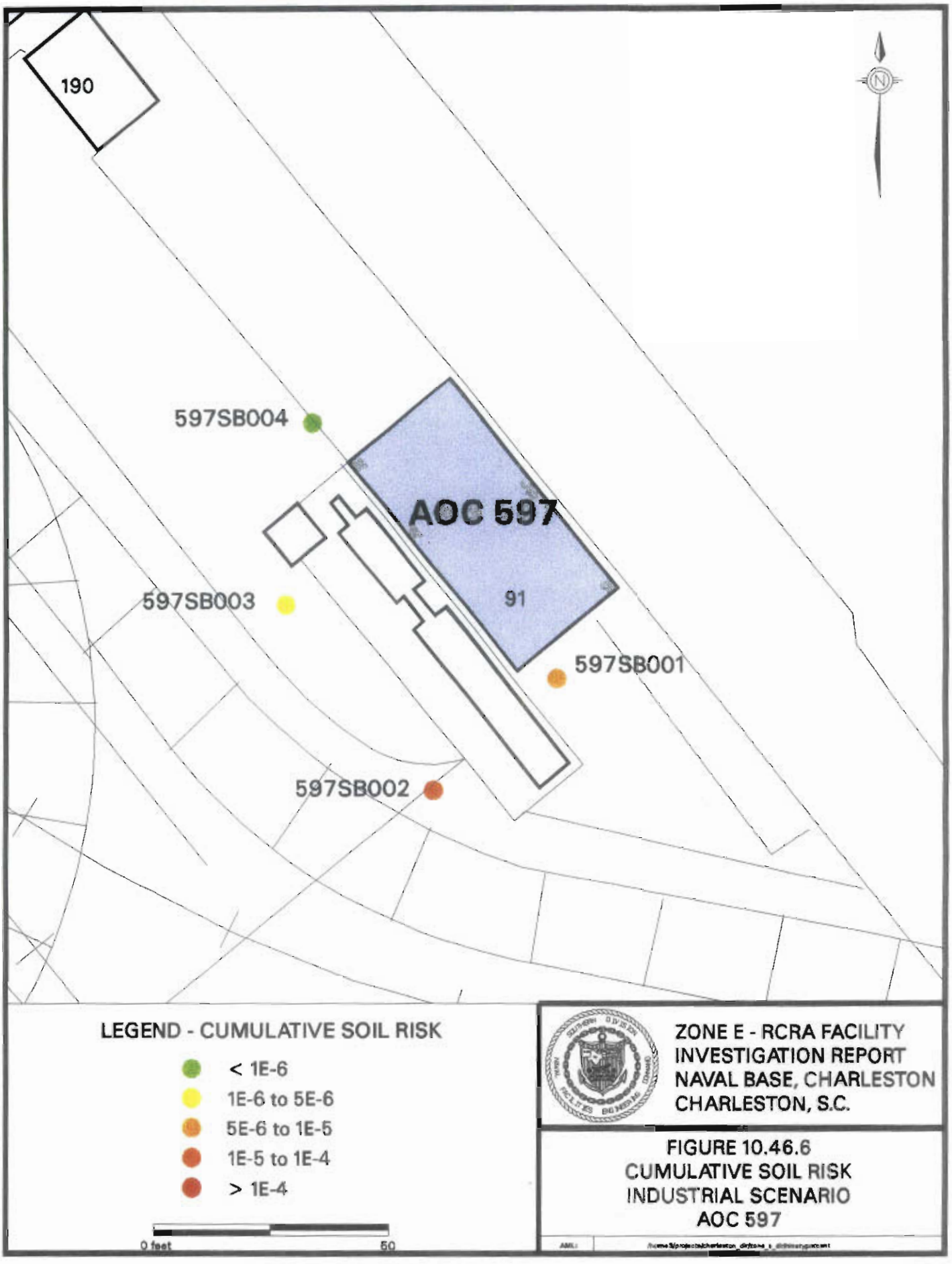
10.46.8.3 Uncertainty

AOC 597 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.


190
597SB004
AOC 597
91
597SB003
597SB001
597SB002
LEGEND - CUMULATIVE SOIL HAZARD
0 to 0.1
0.1 to 0.5
0.5 to 1.0
1.0 to 3.0
> 3.0
0 feet
50
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.46.5
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
AOC 597



ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.46.6
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 597

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 597. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

Beryllium was reported in AOC 597 soil at concentrations above its RBC benchmark, but was eliminated from consideration in the FRE based on comparison to its corresponding background concentration. As a result, its contribution to risk/hazard has not been considered in this FRE.

10.46.8.4 FRE Summary

The risk and hazard posed by contaminants at AOC 597 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. Risk and HI estimates are presented on Table 10.46.8.2 and 10.46.8.3, such that risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target hazard quotient of 1). Section 7, Tables 7.3.1 and 7.3.2 provide residential and industrial RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Aroclor-1248, Aroclor-1254, Aroclor-1260, and arsenic were detected in AOC 597 surface soil at concentrations above their residential risk-based RGOs in all four samples. The calculated mean risk estimate was 6E-05, which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Antimony, Aroclor-1254 and arsenic were detected in AOC 590 surface soil at concentrations above their residential hazard-based RGOs in two of four surface soil samples. The calculated mean hazard estimate was 1.4, which exceeds USEPA's acceptable limit of unity.

Soil — Site Worker Scenario

Aroclor-1248, Aroclor-1254, and arsenic were detected in AOC 590 surface soil at concentrations above their industrial risk-based RGOs in three of four samples. The calculated mean risk estimate was 9E-06, which exceeds the 1E-06 SCDHEC risk level of concern, but is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Aroclor-1254 and arsenic were detected in AOC 590 surface soil at concentrations above their corresponding RBC benchmarks, but their associated HI did not exceed unity at any of the four sample locations.

Table 10.46.8.1
Chemicals Present in Site Samples
AOC 597 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res.	Number Exceeding Ind.	Number Exceeding Ref.
PCBs																
Aroclor-1248	*	*	3	4	63	1600	648	37	37	83	740	NA	UG/KG	2	1	
Aroclor-1254	*	*	1	4	1600	1600	1600	71	75	83	740	NA	UG/KG	1	1	
Aroclor-1260	*		3	4	190	340	241	75	75	83	740	NA	UG/KG	3		
TCDD Equivalents																
Dioxin Equiv.			1	1	5.4605	5.4605	5.46	NA	NA	1000	1000	NA	NG/KG			
Inorganics																
Aluminum (Al)			4	4	1600	4150	2903	NA	NA	7800	100000	26600	MG/KG			
Antimony (Sb)	*		4	4	1.6	4.3	2.6	NA	NA	3.1	82	1.77	MG/KG	1		3
Arsenic (As)	*	*	4	4	0.64	49.3	22.0	NA	NA	0.43	3.8	23.9	MG/KG	4	3	2
Barium (Ba)			4	4	6.3	41.1	29.1	NA	NA	550	14000	130	MG/KG			
Beryllium (Be)			4	4	0.11	0.47	0.30	NA	NA	0.15	1.3	1.7	MG/KG	3		
Cadmium (Cd)			4	4	0.14	0.95	0.49	NA	NA	3.9	100	1.5	MG/KG			
Calcium (Ca)	N		4	4	652	7470	4536	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)			4	4	4.5	22.1	16.45	NA	NA	39	1000	94.6	MG/KG			
Cobalt (Co)			4	4	0.39	7.5	3.40	NA	NA	470	12000	19	MG/KG			
Copper (Cu)			4	4	7.6	151	62.5	NA	NA	310	8200	66	MG/KG			1
Iron (Fe)	N		4	4	2060	11200	6988	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)			4	4	38.8	230	134	NA	NA	400	1300	265	MG/KG			
Magnesium (Mg)	N		4	4	73	628	381	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)			4	4	6.9	64.9	45.5	NA	NA	180	4700	302	MG/KG			
Mercury (Hg)			4	4	0.02	1	0.37	NA	NA	2.3	61	2.6	MG/KG			
Nickel (Ni)			4	4	1.5	14.2	8.88	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N		1	4	593	593	593	249	772	NA	NA	NA	MG/KG			
Selenium (Se)			2	4	0.78	0.78	0.78	0.54	0.55	39	1000	1.7	MG/KG			
Sodium (Na)	N		1	4	148	148	148	34.9	71.5	NA	NA	NA	MG/KG			
Tin (Sn)			4	4	3.1	13.8	8.8	NA	NA	4700	6100	59.4	MG/KG			
Vanadium (V)			4	4	3.3	17.5	11.55	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)			4	4	56.3	499	247	NA	NA	2300	61000	827	MG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not Applicable

Table 10.46.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 597
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
597	B001	Antimony (Sb)	2.30	MG/KG	0.0788	6.18	NA	
597	B001	Aroclor-1248	280.00	UG/KG	NA		1.2704	1.78
597	B001	Aroclor-1254	ND	UG/KG	NA		NA	
597	B001	Aroclor-1260	340.00	UG/KG	NA		1.5426	2.17
597	B001	Arsenic (As)	26.20	MG/KG	1.1975	93.82	68.4344	96.05
		Total			1.2764		71.2474	
597	B002	Antimony (Sb)	2.20	MG/KG	0.0754	2.07	NA	
597	B002	Aroclor-1248	1600.00	UG/KG	NA		7.2593	5.04
597	B002	Aroclor-1254	1600.00	UG/KG	1.3195	36.17	7.2593	5.04
597	B002	Aroclor-1260	193.00	UG/KG	NA		0.8757	0.61
597	B002	Arsenic (As)	49.30	MG/KG	2.2534	61.77	128.7716	89.32
		Total			3.6483		144.1659	
597	B003	Antimony (Sb)	1.60	MG/KG	0.0548	9.23	NA	
597	B003	Aroclor-1248	ND	UG/KG	NA		NA	
597	B003	Aroclor-1254	ND	UG/KG	NA		NA	
597	B003	Aroclor-1260	ND	UG/KG	NA		NA	
597	B003	Arsenic (As)	11.80	MG/KG	0.5394	90.77	30.8216	100.00
		Total			0.5942		30.8216	
597	B004	Antimony (Sb)	4.30	MG/KG	0.1474	83.44	NA	
597	B004	Aroclor-1248	63.00	UG/KG	NA		0.2858	10.14
597	B004	Aroclor-1254	ND	UG/KG	NA		NA	
597	B004	Aroclor-1260	190.00	UG/KG	NA		0.8620	30.57
597	B004	Arsenic (As)	0.64	MG/KG	0.0293	16.56	1.6717	59.29
		Total			0.1767		2.8196	

Table 10.46.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 597
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
597	B001	Aroclor-1248	280.00	UG/KG	NA		0.2583	2.60
597	B001	Aroclor-1254	ND	UG/KG	NA		NA	
597	B001	Arsenic (As)	26.20	MG/KG	0.0602	100.00	9.6811	97.40
		Total			0.0602		9.9394	
597	B002	Aroclor-1248	1600.00	UG/KG	NA		1.4760	6.97
597	B002	Aroclor-1254	1600.00	UG/KG	0.1033	47.69	1.4760	6.97
597	B002	Arsenic (As)	49.30	MG/KG	0.1134	52.31	18.2167	86.05
		Total			0.2167		21.1687	
597	B003	Aroclor-1248	ND	UG/KG	NA		NA	
597	B003	Aroclor-1254	ND	UG/KG	NA		NA	
597	B003	Arsenic (As)	11.80	MG/KG	0.0271	100.00	4.3602	100.00
		Total			0.0271		4.3602	
597	B004	Aroclor-1248	63.00	UG/KG	NA		0.0581	19.73
597	B004	Aroclor-1254	ND	UG/KG	NA		NA	
597	B004	Arsenic (As)	0.64	MG/KG	0.0015	100.00	0.2365	80.27
		Total			0.0015		0.2946	

10.46.9 Corrective Measures Considerations

For AOC 597, the upper and lower soil intervals and a concrete core were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. One of four soil samples was collected from beneath the asphalt pavement.

Antimony, arsenic, and Aroclors 1248, 1254, and 1260 were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 6E-05 and the arithmetic mean HI is 1.4. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and ranges of 3 and 0.1 for HI. Arsenic and Aroclors 1248, 1254, and 1260, were detected in all four soil samples above their risk-based RGOs and antimony was detected in two of four soil samples above its hazard-based RGO. Residential risk-based remedial goals for surface soil set for Aroclors 1248, 1254, and 1260 and arsenic are 0.22, 0.22, 0.22, and 0.38 mg/kg based on a target risk of 1E-06. The hazard-based remedial goal for antimony is 29 mg/kg for a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.46.9.1. Corrective measures for AOC 597 are detailed in Section 9.

Table 10.46.9.1
Potential Corrective Measures for AOC 597

Medium	Compounds	Potential Corrective Measures
Soil	Antimony, arsenic, and Aroclors 1248, 1254, and 1260	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste

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10.47 AOC 598, Sonar Dome Area, End of Pier J; and AOC 599, Pump House, Pier J

AOC 598 is a sonar dome repair area adjacent to Pier J. It consists of a temporary metal building on the asphalt pavement at Pier J. The site is used for repair work, both inside and outside of the building. The area is used to clean and repaint sonar domes and to remove adhesives. Some sanding and media blasting operations are also conducted here. Several storm drains are located in the vicinity. AOC 599 is a pump house on Pier J. The pump house was damaged by Hurricane Hugo in 1989 and since that time, rainwater has collected in the below-grade structure. The pump house was formerly a transfer station for diesel fuel.

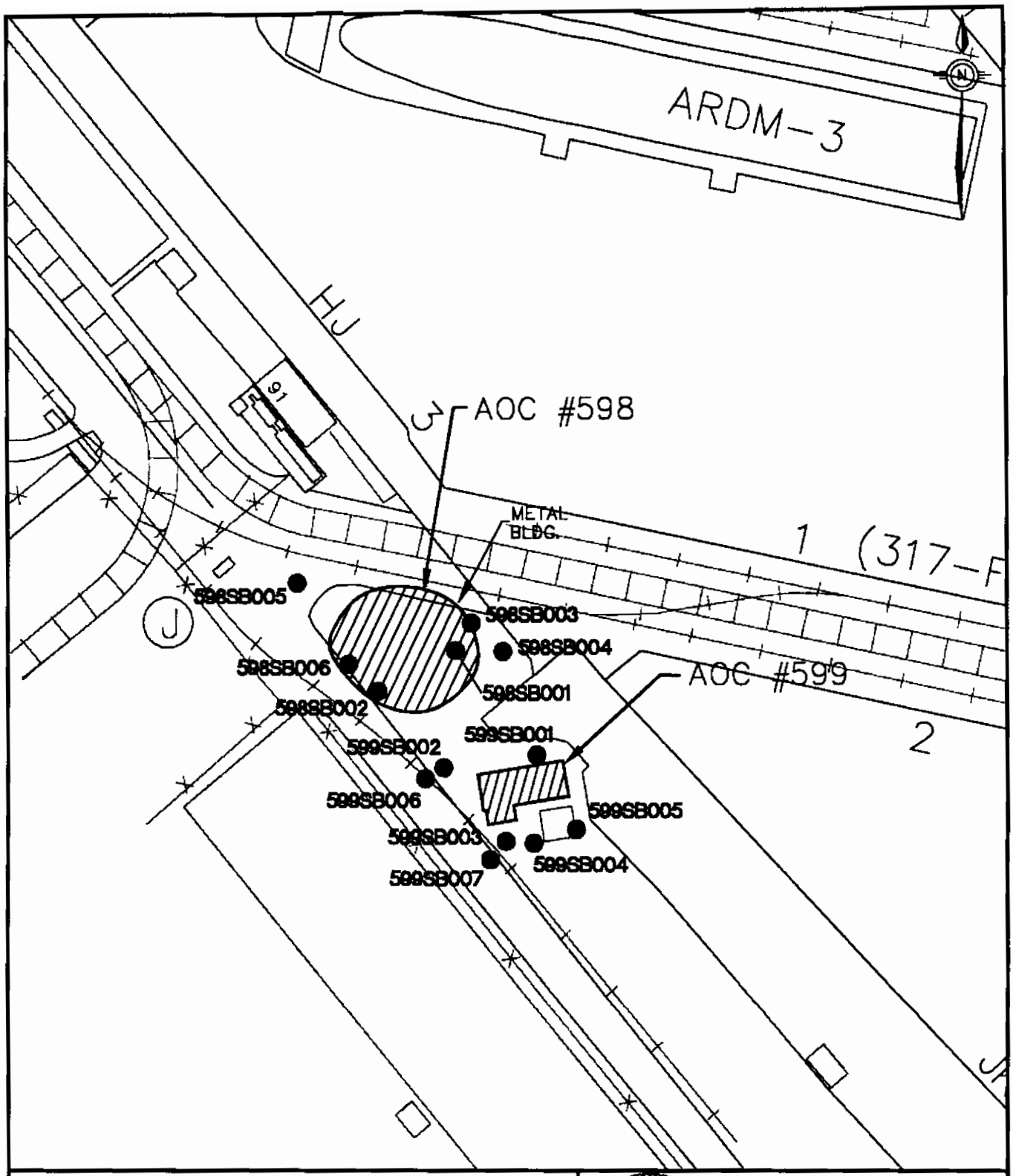
These sites have not been investigated previously, but releases noted during the RFA include overspray of paint on the pavement, blasting media in the asphalt cracks, and waste material in open drains in the area.

Materials of concern at AOC 598, identified in the *Final Zone E RFI Work Plan* include paints, solvents, adhesives, and blasting grit. At AOC 599 the materials of concern are petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI objectives for AOC 598, and the CSI objectives for AOC 599, soil, sediment and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.47.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOCs 598 and 599 from the locations shown in Figure 10.47.1. The *Final Zone E RFI Work Plan*, proposed collecting seven soil samples from the upper interval and seven samples from the lower interval. Soil samples were also collected at both intervals from the two shallow monitoring well locations proposed at this site.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.47.1
SOIL BORING LOCATIONS
AOC #598, SONAR DOME AREA,
END OF PIER J
AOC #599, PIER J PUMP HOUSE

DWG DATE: 09/02/97 | DWG NAME: 10-47-1

First-round Sampling — During the first round of sampling, all nine proposed upper-interval samples and seven of the nine proposed lower-interval samples were collected. Two lower-interval samples at AOC 599 were not collected due to subsurface obstructions such as wood or rocks.

First-round samples were submitted for analysis at DQO Level III for the standard suite of parameters. Two lower-interval samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the suite of parameters proposed for the site, plus a more comprehensive list of VOCs and SVOCs as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.47.1.1 summarizes the first round of soil sampling at AOCs 598 and 599.

Table 10.47.1.1
AOCs 598 and 599
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	9	9	Standard Suite[a]	Standard Suite[a]	None
Lower	9	7	Standard Suite[a]	Standard Suite[a]	Two samples were not taken due to subsurface obstructions

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCBs

Second-round Sampling — Second-round sampling was performed at AOCs 598 and 599 after first-round analytical results were compared to the USEPA Region III RBCs (April 1996). Parameters exceeding RBCs included SVOCs and metals. Section 10.47.2 details specific parameters and locations which exceeded RBCs.

The second round included four upper and four lower-interval samples to determine the extent of constituents detected during first-round sampling. All four proposed upper-interval samples and three of four proposed lower-interval samples were collected. One lower-interval sample could not be collected due to subsurface obstructions such as wood or rocks.

All second-round samples at AOCs 598 and 599 were submitted for analysis of SVOCs and metals. No duplicate samples were collected during the second round of sampling. Table 10.47.1.2 summarizes the second round of soil sampling at AOCs 598 and 599.

Table 10.47.1.2
AOCs 598 and 599
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	SVOCs, metals	SVOCs, metals	None
Lower	4	3	SVOCs, metals	SVOCs, metals	One sample was not taken due to subsurface obstructions

10.47.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.47.2.1. Inorganic analytical results for soil are summarized in Table 10.47.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.47.2.1
AOCs 598 and 599
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	3/9	29.0 - 60.0	46.3	20,000,000	0
	Lower	6/7	26.0 - 78.0	45.5	NA	NA
Methylene chloride	Upper	1/9	4.00	4.00	760,000	0
Toluene	Lower	1/7	2.00	2.00	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Upper	8/13	93.0 - 3,400	1,280	12,000,000	0
	Lower	8/10	52.0 - 1,800	855	NA	NA
Acenaphthylene	Upper	4/13	43.0 - 140	93.8	8,200,000	0
	Lower	2/10	45.0 - 110	77.5	NA	NA
Anthracene	Upper	9/13	67.0 - 6,900	1,560	61,000,000	0
	Lower	7/10	73.0 - 1,300	488	NA	NA
Benzo(g,h,i)perylene	Upper	13/13	92.0 - 5,500	809	8,200,000	0
	Lower	9/10	110 - 850	324	NA	NA
Benzoic acid	Upper	5/13	120 - 250	162	100,000,000	0
	Lower	4/10	100 - 310	203	NA	NA
4-Bromophenyl-phenylether	Upper	1/13	99.0	99.0	12,000,000	0
Butylbenzylphthalate	Upper	1/13	98.0	98.0	41,000,000	0
Carbazole	Lower	1/2	98.0	98.0	NA	NA
2-Chlorophenol	Lower	1/10	77.0	77.0	NA	NA
Dibenzofuran	Upper	7/13	85.0 - 4,100	944	820,000	0
	Lower	5/10	96.0 - 810	415	NA	NA
Di-n-butylphthalate	Upper	1/13	190	190	20,000,000	0
	Lower	2/10	95.0 - 130	113	NA	NA

Table 10.47.2.1
AOCs 598 and 599
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Diethylphthalate	Upper	3/13	100 - 250	153	100,000,000	0
Di-n-octyl phthalate	Upper	1/13	85.0	85.0	4,100,000	0
Fluoranthene	Upper	12/13	240 - 44,000	6,460	8,200,000	0
	Lower	10/10	120 - 7,600	2,140	NA	NA
Fluorene	Upper	8/13	46.0 - 9,000	1,670	8,200,000	0
	Lower	7/10	43.0 - 1,700	630	NA	NA
2-Methylnaphthalene	Upper	6/13	67.0 - 2,600	680	8,200,000	0
	Lower	4/10	70.0 - 2,100	608	NA	NA
Naphthalene	Upper	7/13	44.0 - 3,200	1,050	8,200,000	0
	Lower	3/10	38.0 - 180	106	NA	NA
N-Nitrosodiphenylamine	Upper	1/13	240	240	1,200,000	0
Pentachlorophenol	Lower	1/10	110	110	NA	NA
Phenanthrene	Upper	12/13	130 - 48,000	5,880	8,200,000	0
	Lower	10/10	110 - 3,800	1,040	NA	NA
Pyrene	Upper	13/13	160 - 29,000	4,700	6,100,000	0
	Lower	10/10	99.0 - 5,600	1,750	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	13/13	20.3 - 24,920	2,980	780	4
	Lower	10/10	114 - 2,860	794	NA	NA
Benzo(a)anthracene	Upper	12/13	130 - 19,000	2,650	7,800	2
	Lower	10/10	55.0 - 2,100	668	NA	NA
Benzo(b)fluoranthene	Upper	12/13	93.0 - 17,000	1,890	7,800	1
	Lower	9/10	79.0 - 1,800	609	NA	NA

Table 10.47.2.1
AOCs 598 and 599
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Benzo(k)fluoranthene	Upper	9/13	180 - 8,200	1,230	78,000	0
	Lower	9/10	69.0 - 1,300	469	NA	NA
Benzo(a)pyrene	Upper	12/13	89.0 - 17,000	2,170	780	3
	Lower	10/10	95.0 - 1,800	501	NA	NA
Chrysene	Upper	12/13	160 - 20,000	3,160	780,000	0
	Lower	10/10	66.0 - 1,700	790	NA	NA
Dibenz(a,h)anthracene	Upper	10/13	78.0 - 3,600	588	780	2
	Lower	7/10	43.0 - 570	202	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	12/13	110 - 7,000	986	7,800	0
	Lower	10/10	49.0 - 820	251	NA	NA
Pesticides/PCBs (μg/kg)						
Aldrin	Upper	1/9	2.91	2.91	340	0
delta-BHC	Upper	1/9	6.27	6.27	910	0
gamma-BHC (Lindane)	Upper	1/9	2.39	2.39	4,400	0
alpha-Chlordane	Upper	1/9	7.99	7.99	4,400	0
gamma-Chlordane	Upper	1/9	3.80	3.80	4,400	0
4,4'-DDD	Upper	1/9	132	132	24,000	0
4,4'-DDE	Upper	2/9	6.12 - 59.6	32.9	17,000	0
	Lower	1/7	16.3	16.3	NA	NA
4,4'-DDT	Upper	1/9	21.6	21.6	17,000	0
Endosulfan II	Upper	1/9	10.9	10.9	1,200,000	0
Endrin aldehyde	Upper	1/9	13.8	13.8	61,000	0
Heptachlor epoxide	Upper	1/9	6.20	6.20	630	0
Methoxychlor	Upper	2/9	24.1 - 24.9	24.5	1,000,000	0

Table 10.47.2.1
AOCs 598 and 599
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxin (ng/kg)						
Dioxin Equiv.	Lower	2/2	0.0534 - 0.0646	0.0590	NA	NA
1234678-HpCDD	Lower	2/2	2.51 - 3.08	2.80	NA	NA
OCDD	Lower	2/2	22.6 - 39.5	31.1	NA	NA

Notes:
µg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.47.2.2
AOCs 598 and 599
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	13/13	20,20 - 10,700	5,910	100,000	26,600	0
	Lower	10/10	2,800 - 8,550	6,380	NA	41,100	NA
Antimony (Sb)	Upper	11/13	0.470 - 4.90	1.39	82.0	1.77	0
	Lower	10/10	0.710 - 1.40	0.954	NA	1.60	NA
Arsenic (As)	Upper	13/13	3.90 - 13.5	8.92	3.80	23.9	13
	Lower	10/10	4.10 - 21.6	10.7	NA	19.9	NA
Barium (Ba)	Upper	13/13	15.8 - 104	42.3	14,000	130	0
	Lower	10/10	11.3 - 137	44.0	NA	94.1	NA
Beryllium (Be)	Upper	13/13	0.200 - 0.780	0.422	1.30	1.70	0
	Lower	10/10	0.280 - 0.600	0.449	NA	2.71	NA
Cadmium (Cd)	Upper	10/13	0.220 - 0.810	0.470	100	1.50	0
	Lower	9/10	0.160 - 1.80	0.619	NA	0.960	NA

Table 10.47.2.2
AOCs 598 and 599
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Calcium (Ca)	Upper	13/13	4,920 - 108,000	31,300	NA	NA	NA
	Lower	10/10	14,400 - 179,000	67,600	NA	NA	NA
Chromium (Cr)	Upper	13/13	8.60 - 26.1	17.1	1,000	94.6	0
	Lower	10/10	11.2 - 37.1	23.7	NA	75.2	NA
Cobalt (Co)	Upper	13/13	1.20 - 3.30	2.10	12,000	19.0	0
	Lower	10/10	0.980 - 4.20	1.96	NA	14.9	NA
Copper (Cu)	Upper	13/13	8.40 - 85.6	35.6	8,200	66.0	0
	Lower	10/10	9.40 - 97.1	37.6	NA	152	NA
Cyanide (CN)	Upper	1/9	0.450	0.450	4,100	0.500	0
Iron (Fe)	Upper	13/13	5,320 - 13,000	9,610	61,000	NA	0
	Lower	10/10	6,280 - 24,100	11,800	NA	NA	NA
Lead (Pb)	Upper	13/13	27.5 - 1,810	284	1,300	265	1
	Lower	10/10	8.40 - 1,680	306	NA	173	NA
Magnesium (Mg)	Upper	13/13	404 - 2,930	1,470	NA	NA	NA
	Lower	10/10	1,140 - 5,870	2,650	NA	NA	NA
Manganese (Mn)	Upper	13/13	29.0 - 216	81.4	4,700	302	0
	Lower	10/10	67.5 - 171	110	NA	881	NA
Mercury (Hg)	Upper	13/13	0.0300 - 0.590	0.166	61	2.60	0
	Lower	8/10	0.0400 - 0.530	0.150	NA	1.59	NA
Nickel (Ni)	Upper	13/13	3.90 - 13.7	8.62	4,100	77.1	0
	Lower	10/10	6.80 - 16.8	10.9	NA	57.0	NA
Potassium (K)	Upper	13/13	428 - 1,540	982	NA	NA	NA
	Lower	10/10	384 - 1,710	1,190	NA	NA	NA
Selenium (Se)	Upper	4/13	0.510 - 0.980	0.813	1,000	1.70	0
	Lower	6/10	0.730 - 2.00	1.20	NA	2.40	NA

Table 10.47.2.2
AOCs 598 and 599
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Sodium (Na)	Upper	13/13	254 - 932	464	NA	NA	NA
	Lower	10/10	263 - 1,120	686	NA	NA	NA
Thallium (Tl)	Lower	1/10	0.700	0.700	NA	NA	NA
Tin (Sn)	Upper	11/13	2.50 - 12.3	5.49	100,000	59.4	0
	Lower	8/10	2.80 - 18.1	6.83	NA	9.23	NA
Vanadium (V)	Upper	13/13	8.80 - 30.2	19.0	1,400	94.3	0
	Lower	10/10	15.5 - 30.4	22.6	NA	155	NA
Zinc (Zn)	Upper	13/13	36.0 - 354	172	61,000	827	0
	Lower	10/10	58.2 - 805	280	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Three VOCs were detected in soil samples collected at AOCs 598 and 599. Four detections occurred in the upper interval and seven in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-eight SVOCs were detected in soil samples collected at AOCs 598 and 599. One hundred and ninety-one detections occurred in the upper interval and 149 in the lower interval. Four SVOCs — benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and benzo(a)pyrene — exceeded their respective RBC in the upper interval. Additionally, two SVOCs — benzo(a)anthracene and chrysene — exceeded their respective SSL in the lower interval.

Benzo(a)anthracene was detected in 12 of 13 upper-interval samples with a range of 130 to 19,000 μg/kg and a mean of 2,650 μg/kg. Two upper-interval samples (598SB002, 9,200 μg/kg; and 599SB007, 19,000 μg/kg) exceeded the benzo(a)anthracene industrial RBC of 7,800 μg/kg. Benzo(a)anthracene was detected in 10 of 10 lower-interval samples with a range of 55 of 2,100 μg/kg and a mean of 668 μg/kg. Three lower-interval samples (598SB002, 2,100 μg/kg; 598SB003, 720 μg/kg; 598SB005, 1,500 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Benzo(b)fluoranthene was detected in 12 of 13 upper-interval samples with a range of 93.0 to 17,000 μg/kg and a mean of 1,890 μg/kg. One upper-interval sample (599SB007, 17,000 μg/kg) exceeded the benzo(b)fluoranthene industrial RBC of 7,800 μg/kg.

Benzo(a)pyrene was detected in 12 of 13 upper-interval samples with a range of 89.0 to 17,000 μg/kg and a mean of 2,170 μg/kg. Three upper-interval samples (598SB002, 4,900 μg/kg; 598SB006, 900 μg/kg; and 599SB007, 17,000 μg/kg) exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

In accordance with recent CPAH guidance, BEQs were calculated for cPAHs at AOCs 598 and 599. The upper-interval BEQ was calculated for 13 samples with a range of 20.3 to 24,920 μg/kg and a mean of 2,980 μg/kg. Four samples (598SB002, 7,095 μg/kg; 598SB006, 1,395 μg/kg; 599SB003,1,017 μg/kg; and 599SB007, 24,920 μg/kg) exceeded the BEQ industrial RBC of 780.0 μg/kg.

Chrysene was detected in 10 of 10 lower-interval samples with a range of 66 of 1,700 μg/kg and a mean of 790 μg/kg. Two lower-interval samples (598SB002, 1,700 μg/kg; 598SB003, 1,100 μg/kg; and 598SB005, 1,700 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

Dibenz(a,h)anthracene was detected in 10 of 13 upper-interval samples with a range of 78.0 to 3,600 μg/kg and a mean of 588 μg/kg. Two upper-interval samples (598SB002, 1,000 μg/kg; 599SB007, 3,600 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Pesticides in Soil

Twelve pesticides were detected in soil samples collected at AOCs 598 and 599. Fourteen detections occurred in the upper interval and one in the lower interval. No pesticides were detected above their respective industrial RBC in the upper interval or respective SSL in the lower interval.

Other Organic Compounds in Soil

Two dioxins were detected in the two duplicate soil samples collected at AOCs 598 and 599. Four detections occurred in the lower interval; no upper- interval soil samples were analyzed for dioxins. No SSLs have been established for the detected dioxins.

Inorganic Elements in Soil

Twenty-four metals were detected in soil samples collected at AOCs 598 and 599. Two hundred and seventy-one detections occurred in the upper interval and 202 occurred in the lower interval. One metal — lead — exceeded both its respective industrial RBC and background RC in the upper interval. Additionally, one metal — arsenic — exceeded both its respective SSL and background RC in the lower interval.

Arsenic was detected in 10 of 10 lower-interval samples with a range of 4.10 to 21.6 mg/kg and a mean of 10.7 mg/kg. One lower-interval sample (599SB001, 21.6 μg/kg) exceeded both the arsenic SSL of 15 mg/kg and the background RC of 19.9 mg/kg.

Lead was detected in 13 of 13 upper-interval samples with a range of 27.5 to 1,810 mg/kg and a mean of 284 mg/kg. One upper-interval sample (598SB005, 1,810 mg/kg) exceeded both the lead AL of 1,300 mg/kg and the background RC of 265 mg/kg. One lower-internal sample (598SB002, 1,680 mg/kg) exceeded the lead RC of 173 mg/kg.

10.47.3 Groundwater Sampling and Analysis

Two shallow monitoring wells were installed and sampled to assess groundwater quality at AOCs 598 and 599 as shown in Figure 10.47.2. The wells were installed as follows:

- Shallow Wells — NBCE598001, NBCE599001

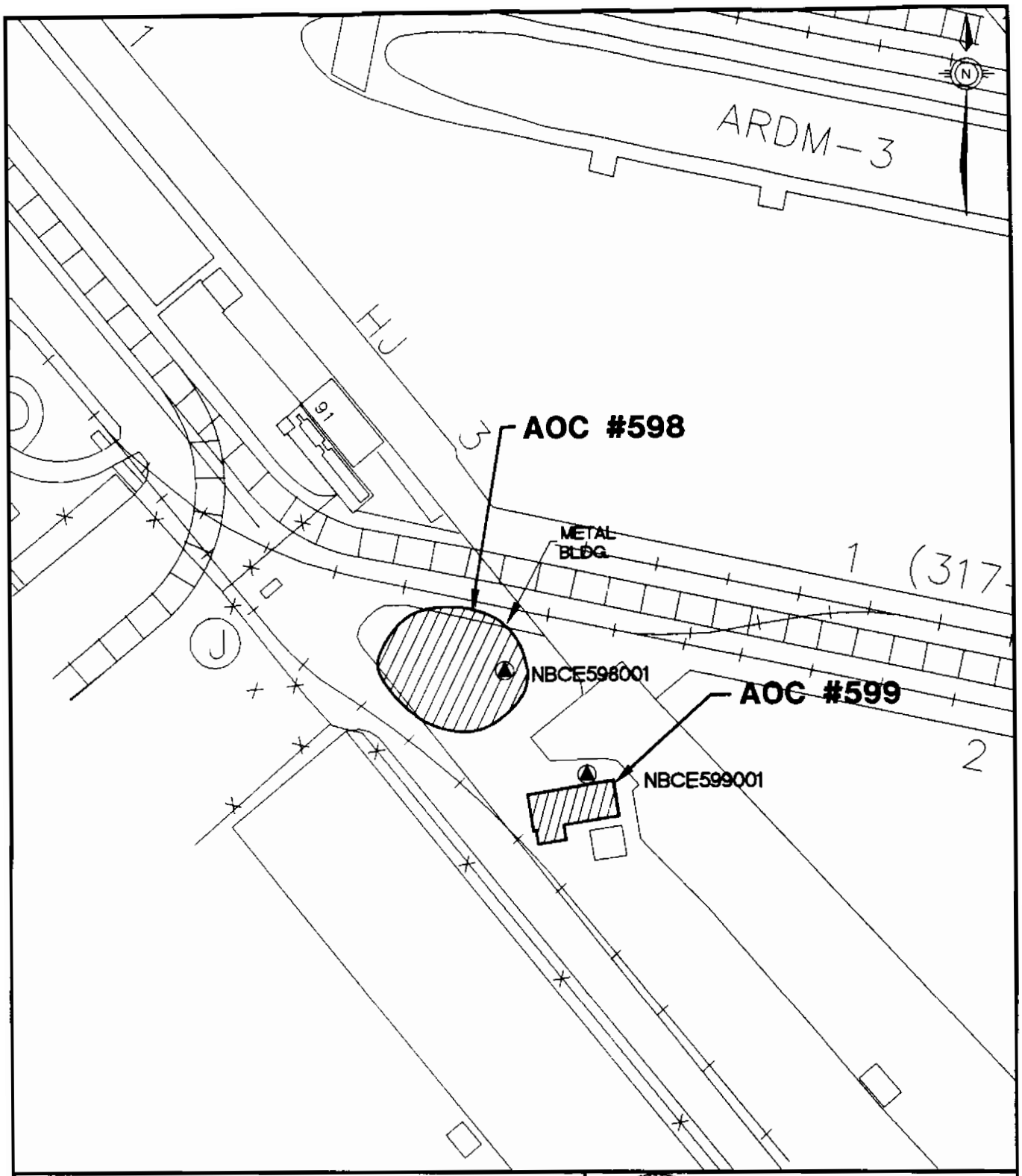
Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, and TDS. No duplicate samples were collected at this site. Table 10.47.3.1 summarizes groundwater sampling and analysis at AOCs 598 and 599.

Table 10.47.3.1
AOCs 598 and 599
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	2	Standard Suite[b], chlorides, TDS, sulfates	Standard Suite[b], chlorides, sulfates, TDS	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring wells were installed at 13 bgs in the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.47.2
MONITORING WELL LOCATIONS
AOC #598, SONAR DOME AREA,
END OF PIER J
AOC #599, PIER J PUMP HOUSE

DWG DATE: 09/02/97 | DWG NAME: 10-47-2

10.47.4 Nature of Contamination in Groundwater

Organic compound analytical results for groundwater are summarized in Table 10.47.4.1. Inorganic analytical results for groundwater are summarized in Table 10.47.4.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.47.4.1
AOCs 598 and 599
Organic Compounds Detected in First Quarter Groundwater (µg/L)
Shallow Monitoring Wells

Compound	Freq. Of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs						
Acenaphthene	1/2	4	4.00	220	NA	0
Benzoic acid	1/2	3	3.00	15,000	NA	0
Fluorene	1/2	1.000	1	150	NA	0
4-Methylphenol (p-Cresol)	1/2	10.0	10.0	18	NA	0
Phenanthrene	1/2	1.000	1	150	NA	0
Pesticides/PCBs						
Heptachlor	1/2	0.058	0.058	0.0023	0.4	1

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
NA = No MCL established

Table 10.47.4.2
AOCs 598 and 599
Inorganic Detections in First Quarter Groundwater (µg/L)
Shallow Monitoring Wells

Element	Freq. Of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/2	41.9	41.9	3,700	2,810	NA	0
Arsenic (As)	1/2	9.00	9.00	0.0450	18.7	50.0	0

Table 10.47.4.2
AOCs 598 and 599
Inorganic Detections in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. Of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Barium (Ba)	1/2	672	672	260	211	2,000	1
Calcium (Ca)	1/2	362,000	362,000	NA	NA	NA	NA
Cyanide (CN)	1/2	4.20	4.20	73.0	7.9	200	0
Iron (Fe)	2/2	12,800 - 67,100	40,000	1,100	NA	NA	2
Magnesium (Mg)	1/2	206,000	206,000	NA	NA	NA	NA
Manganese (Mn)	1/2	187	187	84.0	2,560	NA	0
Nickel (Ni)	1/2	1.3	1.30	73.0	15.2	100	0
Potassium (K)	1/2	108,000	108,000	NA	NA	NA	NA
Sodium (Na)	1/2	3,110,000	3,110,000	NA	NA	NA	NA
Vanadium (V)	2/2	1.70 - 2.50	2.10	26.0	11.4	NA	0
Zinc (Zn)	1/2	16.1	16.1	1,100	27.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC, MCL, or reference concentration established

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Five SVOCs were detected in shallow groundwater samples collected at AOCs 598 and 599. No SVOC exceeded its respective tap-water RBC.

Pesticides and PCBs in Groundwater

Shallow Groundwater

One pesticide was detected in shallow groundwater samples collected at AOCs 598 and 599. The pesticide — heptachlor — exceeded its respective tap-water RBC.

Heptachlor was detected in one of two samples in well NBCE599001 (0.058 μg/L), exceeding its tap-water RBC of 0.00230 μg/L. The detection did not exceed the heptachlor MCL of 0.400 μg/L.

Inorganic Elements in Groundwater

Shallow Groundwater

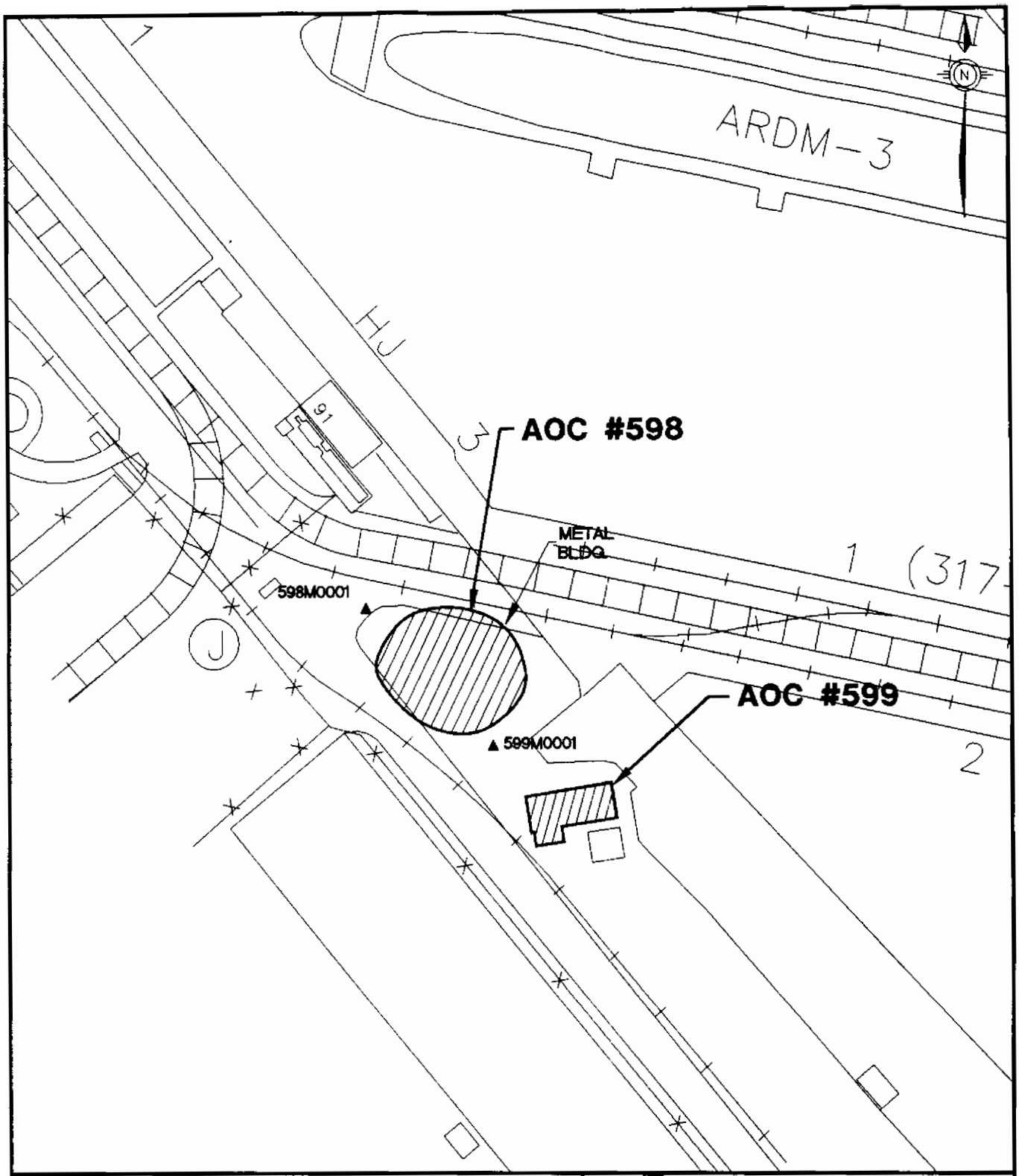
Thirteen metals were detected in shallow groundwater samples collected at AOCs 598 and 599. Two metals — barium and iron — exceeded both their respective tap-water RBC and shallow groundwater RC (where available).

Barium was detected in one of two samples in well NBCE598001 (672 μg/L), exceeding both its tap-water RBC of 260 μg/L and shallow groundwater RC of 211 μg/L. The detection did not exceed the barium MCL of 2,000 μg/L.

Iron was detected in two of two samples with a range of 12,800 to 67,100 μg/L and a mean of 40,000 μg/L. Two samples from wells NBCE598001 (67,100 μg/L) and NBCE599001 (12,800 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No groundwater RC or MCL has been established for iron.

10.47.5 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting two sediment samples at AOCs 598 and 599 from the locations shown in Figure 10.47.3. Two sediment samples were collected and submitted



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
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GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.47.3
SEDIMENT SAMPLE LOCATIONS
AOC #598, SONAR DOME AREA,
END OF PIER J
AOC #599, PIER J PUMP HOUSE

DWG DATE: 09/02/97 | DWG NAME: 10-47-3

for analysis at DQO Level III for VOCs, SVOCs, and metals. No samples were selected as duplicates at this site. Table 10.47.5.1 summarizes sediment sampling and analysis at AOCs 598 and 599.

Table 10.47.5.1
AOCs 598 and 599
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
2	2	Standard Suite[a]	VOCs, SVOCs, and metals	Samples not submitted for pesticides/PCBs or cyanide

Note:
a = Standard suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

10.47.6 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.47.6.1. Inorganic analytical results for sediment are summarized in Table 10.47.6.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.47.6.1
AOCs 598 and 599
Organic Compounds Detected in Sediment (µg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
SVOCs						
Benzo(g,h,i)perylene	Upper	1/2	220	220	8,200,000	0
bis(2-Ethylhexyl)phthalate	Upper	2/2	1,700 - 3,600	2650	410,000	0
Butylbenzylphthalate	Upper	2/2	570 - 610	590	41,000,000	0
Di-n-butylphthalate	Upper	2/2	4,400 - 11,000	7,700	20,000,000	0
Fluoranthene	Upper	2/2	350 - 700	525	8,200,000	0
2-Methylphenol (o-Cresol)	Upper	1/2	86.0	86.0	10,000,000	0

Table 10.47.6.1
AOCs 598 and 599
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
SVOCs						
4-Methylphenol (p-Cresol)	Upper	2/2	270 - 470	370	1,000,000	0
Naphthalene	Upper	1/2	290	290	8,200,000	0
Phenanthrene	Upper	2/2	230 - 340	285	8,200,000	0
Pyrene	Upper	2/2	330 - 680	505	6,100,000	0
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	2/2	143 - 487	315	780	0
Benzo(a)anthracene	Upper	2/2	99.0 - 320	210	7,800	0
Benzo(b)fluoranthene	Upper	2/2	230 - 850	540	7,800	0
Chrysene	Upper	2/2	210 - 520	365	780,000	0
Indeno(1,2,3-cd)pyrene	Upper	1/2	190	190	7,800	0
Benzo(a)pyrene	Upper	2/2	110 - 350	230	780	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial soil RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Table 10.47.6.2
AOCs 598 and 599
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Aluminum (Al)	Upper	2/2	1,410 - 2,650	2,030	100,000	0
Antimony (Sb)	Upper	2/2	1.60 - 1.80	1.70	82	0
Arsenic (As)	Upper	2/2	6.10 - 6.20	6.15	3.8	2
Barium (Ba)	Upper	2/2	17.5 - 68.0	42.8	14,000	0
Beryllium (Be)	Upper	1/2	0.180	0.180	1.3	0
Cadmium (Cd)	Upper	2/2	1.60	1.60	100	0

Table 10.47.6.2
AOCs 598 and 599
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Calcium (Ca)	Upper	2/2	16,200 - 33,600	24,900	NA	NA
Chromium (Cr)	Upper	2/2	26.3 - 72.6	49.5	1,000	0
Cobalt (Co)	Upper	2/2	2.30 - 3.70	3.00	12,000	0
Copper (Cu)	Upper	2/2	5,880 - 17,900	11,900	8,200	1
Iron (Fe)	Upper	2/2	14,900 - 21,300	18,100	NA	NA
Lead (Pb)	Upper	2/2	182 - 368	275	1,300	0
Magnesium (Mg)	Upper	2/2	1,550 - 2,200	1,880	NA	NA
Manganese (Mn)	Upper	2/2	168 - 176	172	4,700	0
Mercury (Hg)	Upper	1/2	0.0500	0.0500	61	0
Nickel (Ni)	Upper	2/2	28.9 - 77.5	53.2	4,100	0
Potassium (K)	Upper	2/2	509 - 739	624	NA	NA
Silver (Ag)	Upper	2/2	0.740 - 1.30	1.02	1,000	0
Sodium (Na)	Upper	2/2	259 - 1,090	675	NA	NA
Thallium (Tl)	Upper	1/2	1.10	1.10	NA	NA
Tin (Sn)	Upper	2/2	8.40 - 17.2	12.8	100,000	0
Vanadium (V)	Upper	2/2	5.90 - 14.7	10.3	1,400	0
Zinc (Zn)	Upper	2/2	1,250 - 3,970	2610	61,000	0

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Volatile Organic Compounds in Sediment

No VOCs were detected in the sediment samples submitted for laboratory analysis from AOCs 598 and 599.

Semivolatile Organic Compounds in Sediment

Fifteen SVOCs were detected in 26 of 30 sediment samples collected at AOCs 598 and 599. None of the detected SVOCs exceeded their respective industrial soil RBCs.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOCs 598 and 599. The BEQ was calculated for two samples with a range of 143 to 487 μg/kg and a mean of 315 μg/kg. None of the detections exceeded the BEQ industrial RBC of 780 μ/kg.

Inorganic Elements in Sediment

Twenty-three metals were detected in sediment samples collected at AOCs 598 and 599. Two metals — arsenic and copper — exceeded their respective industrial soil RBC.

Arsenic was detected in two of two samples with a range of 6.10 to 6.20 mg/kg and a mean of 6.15 mg/kg. Both samples (598M0001, 6.2 mg/kg; 599M0001, 6.1 mg/kg) exceeded the arsenic industrial RBC of 3.8 mg/kg.

Copper was detected in two of two samples with a range of 5,880 to 17,900 mg/kg and a mean of 11,900 mg/kg. One sample (599M0001, 17,900 mg/kg) exceeded the copper industrial RBC of 8,200 mg/kg.

10.47.7 Fate and Transport Assessment for AOCs 598 and 599

AOC 598 is a sonar dome repair area consisting of a temporary metal building on asphalt, adjacent to Pier J. AOC 599 is a pump house and former diesel fuel transfer station on Pier J. The physical setting of the sites consists entirely of concrete and asphalt pavement and other buildings. Environmental media sampled as part of the combined AOC 598 RFI include surface soil, subsurface soil, sediment, and shallow groundwater. Potential constituent migration pathways

investigated for combined AOC 598 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of volatiles from surface soil to air.

10.47.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.47.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background reference concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Six organic compounds — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, pentachlorophenol, and delta-BHC — were detected in combined AOC 598 soil at concentrations exceeding their generic groundwater protection SSLs. Benzo(a)anthracene was detected at a concentration above its SSL in three surface soil samples (598SB002, 599SB003, and 599SB007) and two subsurface soil samples (598SB002 and 598SB005). Benzo(a)pyrene and dibenzo(a,h)anthracene exceeded their generic SSLs in the same two surface soil samples (598SB002 and 599SB007). Benzo(b)fluoranthene exceeded its SSL in only one surface soil sample (599SB007). Pentachlorophenol exceeded its groundwater protection SSL in one subsurface soil sample (598SB002), and delta-BHC exceeded its SSL in one surface soil sample (598SB002).

Two inorganics — antimony and lead — were detected in combined AOC 598 soil at concentrations exceeding their groundwater protection standards. Antimony was detected at a concentration exceeding its generic SSL in one surface soil sample (598SB001). Lead was detected at a concentration exceeding its de facto SSL in two surface soil samples (598SB005 and 599SB002) and two subsurface soil samples (598SB001 and 598SB002). No constituent (organic or inorganic)

exceeding first-tier soil screening values was detected in first-quarter groundwater samples at combined AOC 598, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

10.47.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.47.7.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Heptachlor was detected in first-quarter groundwater samples collected for combined AOC 598 at a concentration exceeding both its groundwater and surface water standards. Although its detected concentration of 0.058 μg/L was greater than its tap water RBC of 0.0023 μg/L and its saltwater surface water chronic screening level of 0.0036 μg/L in one first-quarter groundwater sample from well NBCE599001, it did not exceed its respective MCL of 0.4 μg/L. Heptachlor was not detected in shallow groundwater samples collected during subsequent quarterly sampling. No other organic constituents were detected at concentrations exceeding first-tier screening values.

No inorganics were detected in combined AOC 598 first-quarter groundwater samples at concentrations exceeding their respective tap water RBCs and/or background reference values for groundwater.

10.47.7.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.47.7.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined AOC 598 is 76,800:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.47.7.4 Surface Soil-to-Sediment Cross-Media Transport

Two sediment samples were collected from catch basins at combined AOC 598. Tables 10.47.6.1 and 10.47.6.2 summarize the organic and inorganic constituent concentrations detected in sediment samples at combined AOC 598. Nearly all of the constituents detected in sediment samples were also detected in surface soil samples at the site, including many SVOCs, cPAHs, and inorganics. This relationship implies either that surface soil is a potential source of these constituents in sediment, which is unlikely since the area is entirely paved, or that both surface soil and sediment were contaminated by similar site sources. Fate and transport for constituents detected in catch-basin sediment will be discussed in the Zone L RFI report.

10.47.7.5 Soil-to-Air Cross-Media Transport

Table 10.47.7.3 lists the VOCs detected in surface soil samples collected at combined AOC 598 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at combined AOC 598. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at combined AOC 598.

10.47.7.6 Fate and Transport Summary

Of the eight organic and inorganic soil constituents detected at concentrations exceeding groundwater protection SSLs, none was detected in first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

Heptachlor was the only constituent identified in the first-tier groundwater screening. It was detected at a concentration exceeding its tap water RBC and its saltwater surface water chronic screening level in one first-quarter shallow groundwater sample. However, the detected concentration of heptachlor was below its respective MCL and the compound was not detected in subsequent sampling rounds, indicating it poses no threat to surface water in the Cooper River via the groundwater-to-surface water migration pathway.

No constituent exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.47.7.1
Chemicals Detected in Surface Soil, Subsurface Soil and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 598 and 599
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	60	78	ND	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	4	ND	ND	NA	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
Toluene	ND	2	ND	NA	6000	750	37	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	3400	1800	4	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	140	110	ND	NA	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	6900	1300	ND	NA	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	250	310	3	NA	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	5500	850	ND	NA	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	19000	2100	ND	NA	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	17000	1800	ND	NA	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	17000	1800	ND	NA	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	8200	1300	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	20000	1700	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	3600	570	ND	NA	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	7000	820	ND	NA	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
4-Bromophenyl-phenylether	99	ND	ND	NA	718000	2100	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	98	ND	ND	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Carbazole	98	98	ND	NA	300	3.4	NA	UG/KG	UG/L	NO	NO	NO
2-Chlorophenol	ND	77	ND	NA	2000	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	4100	810	ND	NA	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	190	130	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	250	ND	ND	NA	235000	29000	75.9	UG/KG	UG/L	NO	NO	NO
Di-n-octyl phthalate	85	ND	ND	NA	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	85	ND	ND	NA	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	44000	7600	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	9000	1700	1	NA	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	2600	2100	ND	NA	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylphenol (o-cresol)	ND	ND	ND	NA	7500	1800	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	ND	10	NA	690	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	3200	180	ND	NA	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
N-Nitrosodiphenylamine	240	ND	ND	NA	600	14	33000	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	ND	110	ND	NA	15	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	48000	3800	1	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	29000	5600	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aldrin	2.91	ND	ND	NA	250	0.004	0.13	UG/KG	UG/L	NO	NO	NO
delta-BHC	6.27	ND	ND	NA	1.5	0.037	NA	UG/KG	UG/L	YES	NO	NO
gamma-BHC (Lindane)	2.39	ND	ND	NA	4.5	0.052	0.016	UG/KG	UG/L	NO	NO	NO
alpha-Chlordane	7.99	ND	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	3.8	ND	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	132	ND	ND	NA	8000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	59.6	16.3	ND	NA	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	21.6	ND	ND	NA	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Endosulfan II	10.9	ND	ND	NA	9000	220	0.0087	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	13.8	ND	ND	NA	500	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor	ND	ND	0.058	NA	11500	0.0023	0.0036	UG/KG	UG/L	NO	YES	YES
Heptachlor epoxide	6.2	ND	ND	NA	350	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Methoxychlor	24.9	ND	ND	NA	80000	180	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	NA	0.0646	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO

Table 10.47.7.1
Chemicals Detected in Surface Soil, Subsurface Soil and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 598 and 599
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Inorganic Compounds												
Aluminum	10700	8550	41.9	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	4.9	1.4	ND	NA	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	13.5	21.6	9	NA	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	104	137	672	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.78	0.6	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.81	1.8	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	26.1	37.1	ND	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	3.3	4.2	ND	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	85.6	97.1	ND	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.45	ND	4.2	NA	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	1810	1680	ND	NA	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	216	171	187	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.59	0.53	ND	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	13.7	16.8	1.3	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.98	2	ND	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.7	ND	NA	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	12.3	18.1	ND	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	30.2	30.4	2.5	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	354	805	16.1	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.47.7.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 598 and 599
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	Tap Water RBC Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	19000	2100	ND	NA	800	0.092	NA	0.092	7.07E+03	0.1	7.07E+04	5.65E+06	UG/KG	UG/L	NO	NO
Benzo(a)pyrene	17000	1800	ND	NA	4000	0.0092	NA	0.0092	7.07E+02	0.2	3.53E+03	1.41E+06	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	17000	1800	ND	NA	2500	0.092	NA	0.092	7.07E+03	0.1	7.07E+04	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	3600	570	ND	NA	800	0.0092	NA	0.0092	7.07E+02	0.01	7.07E+04	5.65E+06	UG/KG	UG/L	NO	NO
Pentachlorophenol	ND	110	ND	NA	15	0.56	7.9	0.56	4.30E+04	1	4.30E+04	6.45E+04	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
delta-BHC	6.27	ND	ND	NA	1.5	0.037	NA	0.037	2.84E+03	0.05	5.68E+04	8.52E+03	UG/KG	UG/L	NO	NO
Heptachlor	ND	ND	0.058	NA	11500	0.0023	0.0036	0.0023	1.77E+02	0.4	4.42E+02	5.08E+05	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	4.9	1.4	ND	NA	2.5	15	NA	15	1.15E+06	6	1.92E+05	4.80E+04	MG/KG	UG/L	NO	NO
Lead	1810	1680	ND	NA	400	15	8.5	8.5	6.53E+05	15	4.35E+04	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 76,800: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.47.7.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 598 and 599
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	60	62000000	UG/KG	NO
Methylene chloride	4	7000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.47.8 Fixed-Point Risk Evaluation for AOC 598 and AOC 599

10.47.8.1 Site Background and Investigative Approach

AOC 598 is a sonar dome repair area and AOC 599 is a pump house. Both sites are located near Pier J. The following refers to these sites as combined AOC 598. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment is presented as a FRE following the framework presented in Section 7.3.

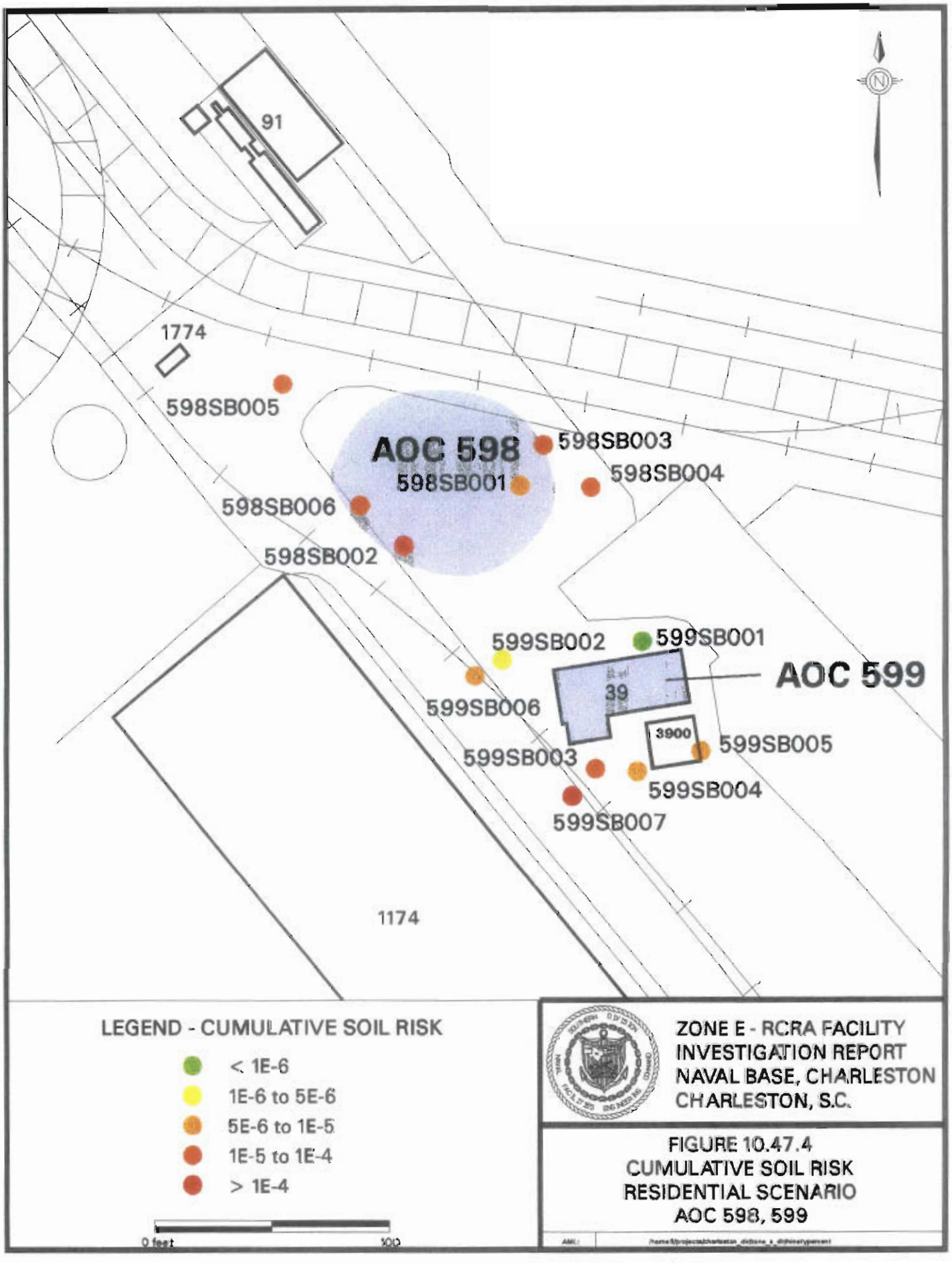
All of the 13 surface soil samples collected during the combined AOC 598 RFI were included in the FRE. Two monitoring wells were installed into the shallow aquifer as part of the 1995 RFI. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the combined AOC 598 FRE. Sections 10.47.1 and 10.47.3 contain summaries of the sampling effort for combined AOC 598 soil and groundwater.

10.47.8.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.47.8.1 provides CPSS summaries for combined AOC 598 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, antimony, BEQ equivalents, and lead were identified as COPCs for combined AOC 598. Aluminum, arsenic, beryllium, and manganese were detected in combined AOC 598 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE based on comparison to their background concentrations. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.47.8.2 summarizes the residential COPCs detected at each combined AOC 598 sample location with contribution to risk and hazard. As shown, BEQ equivalent compounds contribute to risk for combined AOC 598 surface soil, exceeding 1E-06 at 12 of 13 locations. Figure 10.47.4


91
1774
598SB005
AOC 598
598SB003
598SB001
598SB004
598SB006
598SB002
599SB002
599SB001
AOC 599
39
599SB006
3900
599SB005
599SB003
599SB004
599SB007
1174
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
100
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.47.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 598, 599

is a spatial presentation of residential risk estimates for combined AOC 598 surface soil. Risk estimates range from 3E-07 to 4E-04 with an arithmetic mean risk of 5E-05. HI estimates did not exceed unity at any sample locations. Hazard indices range from 0.02 to 0.2.

Industrial Scenario

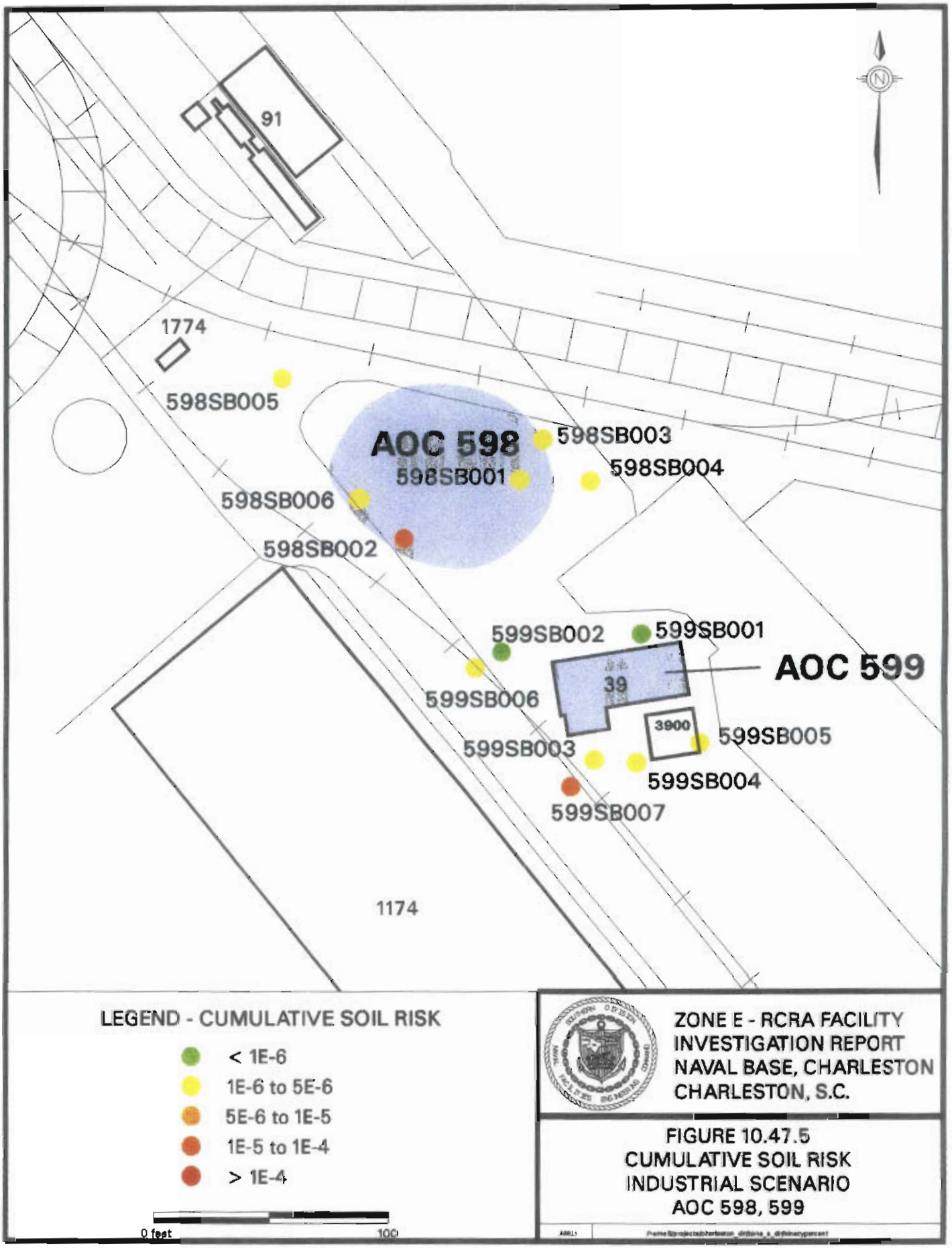
Based on industrial RBCs, BEQ equivalents and lead were identified as COPCs for combined AOC 598 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.47.8.3 summarizes the industrial COPCs detected at each combined AOC 598 sample location with contribution to risk and hazard. As shown, BEQ equivalent compounds contribute to risk for combined AOC 598 surface soil, exceeding 1E-06 at 11 of 13 locations. Figure 10.47.5 is a spatial presentation of industrial risk estimates for combined AOC 598 surface soil. Risk estimates range from 7E-08 to 8E-05 with an arithmetic mean risk of 1E-05.

No industrial COPCs were detected that would have contributed to HI projections.

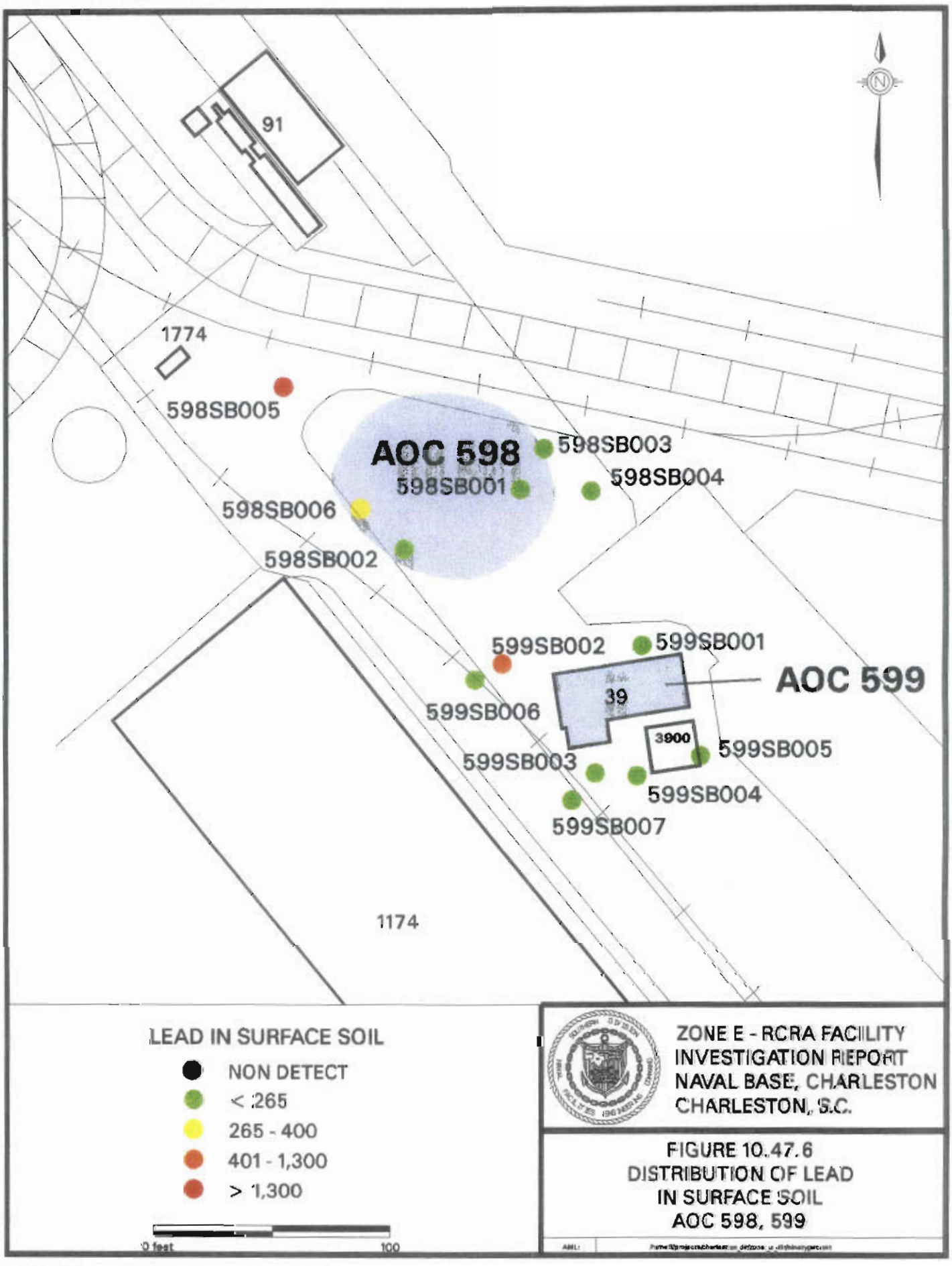
Lead

Lead was detected in all 13 surface soil samples collected at combined AOC 598. Soil concentrations ranged from 28.5 to 1810 mg/kg and exceeded the residential clean up level of 400 mg/kg in only two of 13 samples. The mean detected lead concentration for combined AOC 598 is 284 mg/kg which is below the action level of 400 mg/kg, considered protective of children under a residential scenario. Figure 10.47.6 is a spatial presentation of lead soil concentrations, using the surface soil background concentration of 265 mg/kg, the residential soil lead cleanup level of 400 mg/kg, and the industrial soil lead cleanup concentration of 1,300 mg/kg as benchmark levels to illustrate the lead soil concentrations for combined AOC 598. As shown,



ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.47.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 598, 599



ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.47.6
DISTRIBUTION OF LEAD
IN SURFACE SOIL
AOC 598, 599

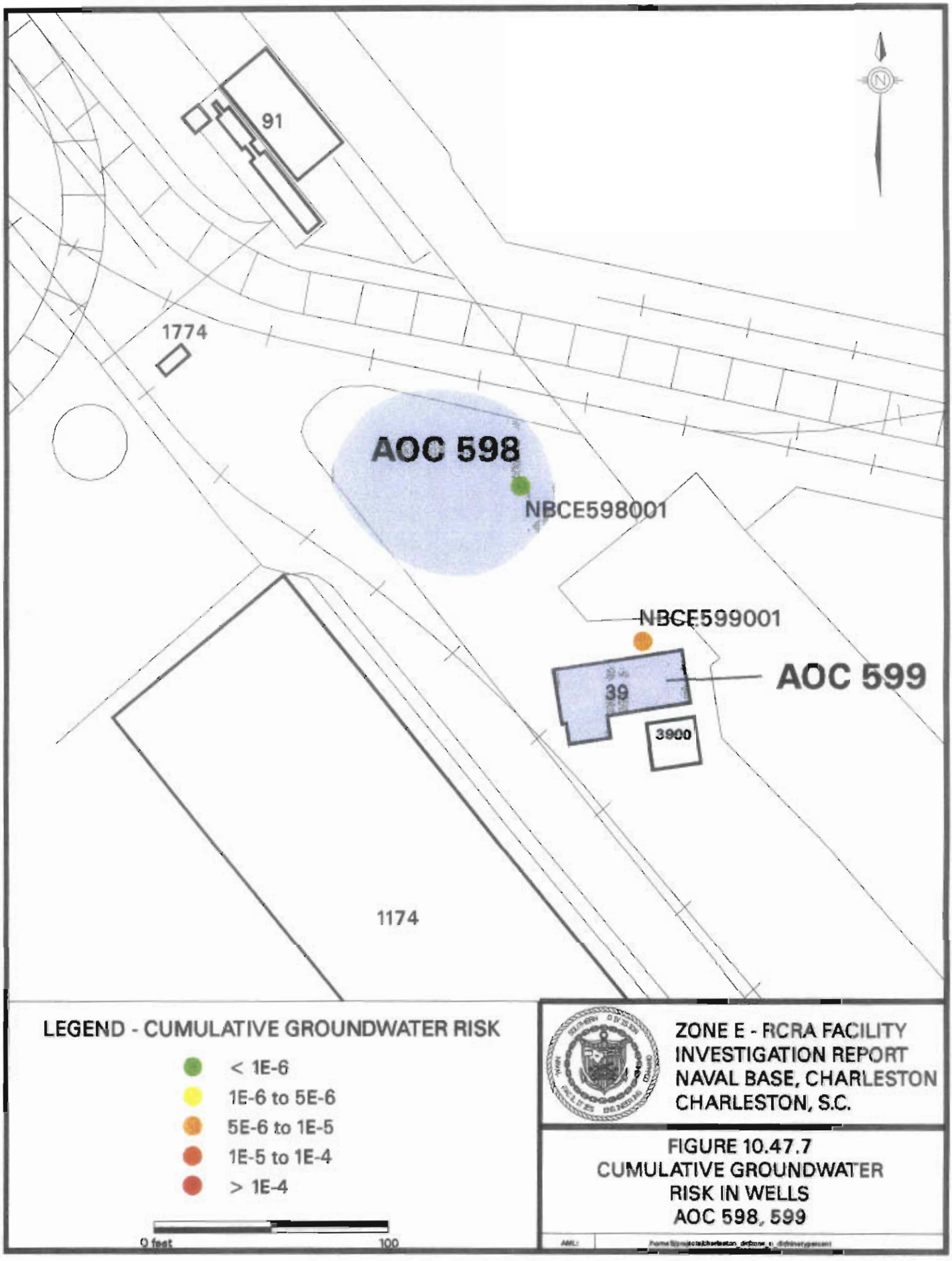
surface soil sample 598SB005, which is located on the perimeter of the soil sampling array, reported a concentration of 1,810 mg/kg lead. Although soil samples collected for the AOC 597 RFI define the extent of lead in soil to the north of sample location 598SB005, it is unclear whether the extent has been adequately defined to the west of sample location 598SB005.

10.47.8.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.47.8.4 provides CPSS summaries for combined AOC 598 groundwater and identifies COPCs. Barium and heptachlor were identified as groundwater COPCs in the shallow aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. The maximum concentrations of arsenic and manganese reported in the shallow well samples exceeded their RBCs and were eliminated from consideration in the groundwater FRE based on comparison to background RCs. Combined AOC 598 shallow groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples). As a result, arsenic and manganese were eliminated from the shallow groundwater FRE based on direct comparison of their maximum concentrations to their background RCs.

Table 10.47.8.5 summarizes the COPCs identified in combined AOC 598 monitoring wells sampled during the first quarter. The concentrations of heptachlor in the groundwater sample collected from monitoring well NBCE599001 was associated with risk estimate of 8E-06. There were no carcinogenic COPCs detected in the first quarter groundwater samples collected from monitoring well NBCE598001. Figure 10.47.7 illustrates the groundwater data as a function of point specific risk projections.

Concentrations of barium in first quarter groundwater samples were not associated with HI projections above unity. HI projections were 0.6 and 0.01 for first quarter groundwater samples collected from monitoring wells NBCE598001 and NBCE599001, respectively.


91
1774
AOC 598
NBCE598001
NBCE599001
AOC 599
39
3900
1174
LEGEND - CUMULATIVE GROUNDWATER RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
100
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.47.7
CUMULATIVE GROUNDWATER
RISK IN WELLS
AOC 598, 599

10.47.8.4 Uncertainty

AOC 598 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined AOC 598, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined AOC 598. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBCs (e.g., within 10% of its RBCs).

Aluminum, arsenic, beryllium, and manganese were reported in combined AOC 598 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBCs (e.g., within 10% of its RBCs).

Arsenic and manganese were reported in combined AOC 598 shallow groundwater at maximum concentrations above corresponding RBC benchmarks and were eliminated from consideration in the groundwater FRE based on comparison to its background concentration. As a result, their contribution to risk/hazard has not been considered in groundwater FRE.

10.47.8.5 FRE Summary

The risk and hazard posed by contaminants at combined AOC 598 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.47.8.2, 10.47.8.3, and 10.47.8.5 such that risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

BEQ equivalents were reported at concentrations above their residential RGO in 12 of 13 surface soil samples.

Soil — Site Worker Scenario

BEQ equivalents were reported at concentrations above their industrial RGO in 11of 13 surface soil samples.

Groundwater — Residential Scenario

Heptachlor epoxide was detected in shallow groundwater at a concentration above its RGO based on first quarter groundwater samples. Heptachlor epoxide was not detected in subsequent quarterly samples. Thallium (MCL = 2 μg/L) was detected in the third quarter groundwater samples collected from both combined AOC 598 monitoring wells at concentrations of 8.2 μg/L (NBCE598001) and 3.3 μg/L (NBCE599001). Thallium was not detected in first, second, or fourth quarter groundwater samples collected from these monitoring wells. The mean thallium groundwater concentrations for all four quarters was calculated to be 3 μg/L, assuming one-half the SQL for nondetects, which is only marginally above its MCL.

Table 10.47.8.1
Chemicals Present in Site Samples
AOC 598 and AOC 599 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Carcinogenic PAHs																
B(a)P Equiv.	*	*	13	13	20.3	24920	2979	NA	NA	88	780	NA	UG/KG	12	4	
Benzo(a)anthracene	*	*	12	13	130	19000	2646	890	890	880	7800	NA	UG/KG	2	2	
Benzo(b)fluoranthene	*	*	12	13	93	17000	1891	2000	2000	880	7800	NA	UG/KG	2	1	
Chrysene			12	13	160	20000	3163	890	890	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	*	10	13	78	3600	588	380	890	88	780	NA	UG/KG	9	2	
Indeno(1,2,3-cd)pyrene	*		12	13	110	7000	986	800	800	880	7800	NA	UG/KG	2		
Benzo(k)fluoranthene			9	13	180	8200	1234	380	890	8800	78000	NA	UG/KG			
Benzo(a)pyrene	*	*	12	13	89	17000	2172	890	890	88	780	NA	UG/KG	12	3	
Inorganics																
Aluminum (Al)			13	13	2020	10700	5910	NA	NA	7800	100000	26600	MG/KG	1		
Antimony (Sb)	*		11	13	0.47	4.9	1.39	0.46	0.47	3.1	82	1.77	MG/KG	1		3
Arsenic (As)			13	13	3.9	13.5	8.92	NA	NA	0.43	3.8	23.9	MG/KG	13	13	
Barium (Ba)			13	13	15.8	104	42.32	NA	NA	550	14000	130	MG/KG			
Beryllium (Be)			13	13	0.2	0.78	0.42	NA	NA	0.15	1.3	1.7	MG/KG	13		
Cadmium (Cd)			10	13	0.22	0.81	0.47	0.11	0.13	3.9	100	1.5	MG/KG			
Calcium (Ca)	N		13	13	4920	108000	31348	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)			13	13	8.6	26.1	17.14	NA	NA	39	1000	94.6	MG/KG			
Cobalt (Co)			13	13	1.2	3.3	2.1	NA	NA	470	12000	19	MG/KG			
Copper (Cu)			13	13	8.4	85.6	35.58	NA	NA	310	8200	66	MG/KG			3
Cyanide (CN)			1	9	0.45	0.45	0.45	0.22	0.26	160	4100	0.5	MG/KG			
Iron (Fe)	N		13	13	5320	13000	9609	NA	NA	NA	NA	NA	MG/KG			
Lead (Pb)	*	*	13	13	27.5	1810	284	NA	NA	400	1300	265	MG/KG	2	2	3
Magnesium (Mg)	N		13	13	404	2930	1471	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)			13	13	29	216	81.42	NA	NA	180	4700	302	MG/KG	1		
Mercury (Hg)			13	13	0.03	0.59	0.17	NA	NA	2.3	61	2.6	MG/KG			
Nickel (Ni)			13	13	3.9	13.7	8.62	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N		13	13	428	1540	982	NA	NA	NA	NA	NA	MG/KG			
Selenium (Se)			4	13	0.51	0.98	0.81	0.35	0.64	39	1000	1.7	MG/KG			

Table 10.47.8.1
Chemicals Present in Site Samples
AOC 598 and AOC 599 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Sodium (Na)	N	13	13	254	932	464	NA	NA	NA	NA	NA	MG/KG			
Tin (Sn)		11	13	2.5	12.3	5.49	1.6	2	4700	6100	59.4	MG/KG			
Vanadium (V)		13	13	8.8	30.2	18.98	NA	NA	55	1400	94.3	MG/KG			
Zinc (Zn)		13	13	36	354	172	NA	NA	2300	61000	827	MG/KG			
Pesticides															
Aldrin		1	9	2.91	2.91	2.91	1.51	1.76	38	340	NA	UG/KG			
delta-BHC		1	9	6.27	6.27	6.27	1.43	1.76	100	910	NA	UG/KG			
gamma-BHC (Lindane)		1	9	2.39	2.39	2.39	1.51	1.76	490	4400	NA	UG/KG			
alpha-Chlordane		1	9	7.99	7.99	7.99	1.51	1.76	470	2200	NA	UG/KG			
gamma-Chlordane		1	9	3.8	3.8	3.8	1.51	1.76	470	2200	NA	UG/KG			
4,4'-DDD		1	9	132	132	132	2.91	3.38	2700	24000	NA	UG/KG			
4,4'-DDE		2	9	6.12	59.6	32.86	2.91	3.38	1900	17000	NA	UG/KG			
4,4'-DDT		1	9	21.6	21.6	21.6	2.91	3.38	1900	17000	NA	UG/KG			
Endosulfan II		1	9	10.9	10.9	10.9	2.91	3.38	47000	1200000	NA	UG/KG			
Endrin aldehyde		1	9	13.8	13.8	13.8	2.91	3.38	2300	61000	NA	UG/KG			
Heptachlor epoxide		1	9	6.2	6.2	6.2	1.51	1.76	70	630	NA	UG/KG			
Methoxychlor		2	9	24.1	24.9	24.5	15.1	17.6	39000	1000000	NA	UG/KG			
Semivolatile Organics															
Acenaphthene		8	13	93	3400	1275	360	890	470000	12000000	NA	UG/KG			
Acenaphthylene		4	13	43	140	93.75	360	2000	310000	8200000	NA	UG/KG			
Anthracene		9	13	67	6900	1563	770	890	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene		13	13	92	5500	809	NA	NA	310000	8200000	NA	UG/KG			
Benzoic acid		5	13	120	250	162	1800	9500	31000000	100000000	NA	UG/KG			
4-Bromophenyl-phenylether		1	13	99	99	99	360	2000	450000	12000000	NA	UG/KG			
Butylbenzylphthalate		1	13	98	98	98	360	2000	1600000	41000000	NA	UG/KG			
Dibenzofuran		7	13	85	4100	944	360	890	31000	820000	NA	UG/KG			
Di-n-butylphthalate		1	13	190	190	190	360	2000	780000	20000000	NA	UG/KG			
Diethylphthalate		3	13	100	250	153	360	890	6300000	100000000	NA	UG/KG			

Table 10.47.8.1
Chemicals Present in Site Samples
AOC 598 and AOC 599 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
Di-n-octyl phthalate	1	13	85	85	85	360	2000	160000	4100000	NA	UG/KG			
Fluoranthene	12	13	240	44000	6460	890	890	310000	8200000	NA	UG/KG			
Fluorene	8	13	46	9000	1672	360	890	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	6	13	67	2600	680	360	2000	310000	8200000	NA	UG/KG			
Naphthalene	7	13	44	3200	1050	360	2000	310000	8200000	NA	UG/KG			
N-Nitrosodiphenylamine	1	13	240	240	240	360	2000	130000	1200000	NA	UG/KG			
Phenanthrene	12	13	130	48000	5884	890	890	310000	8200000	NA	UG/KG			
Pyrene	13	13	160	29000	4702	NA	NA	230000	6100000	NA	UG/KG			
Volatile Organics														
Acetone	3	9	29	60	46.33	30	81	780000	20000000	NA	UG/KG			
Methylene chloride	1	9	4	4	4	6	25	85000	760000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligram per kilogram
UG/KG - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not Applicable

Table 10.47.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 598 and 599
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
598	B001	Antimony (Sb)	4.90	MG/KG	0.1680	100.00	NA	
598	B001	B(a)P Equiv.	590.85	UG/KG	NA		9.7847	100.00
598	B001	Lead (Pb)	127.00	MG/KG	NA		NA	
		Total			0.1680		9.7847	
598	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
598	B002	B(a)P Equiv.	7095.00	UG/KG	NA		117.4954	100.00
598	B002	Lead (Pb)	212.00	MG/KG	NA		NA	
		Total			NA		117.4954	
598	B003	Antimony (Sb)	0.78	MG/KG	0.0267	100.00	NA	
598	B003	B(a)P Equiv.	609.83	UG/KG	NA		10.0990	100.00
598	B003	Lead (Pb)	60.30	MG/KG	NA		NA	
		Total			0.0267		10.0990	
598	B004	Antimony (Sb)	1.80	MG/KG	0.0617	100.00	NA	
598	B004	B(a)P Equiv.	748.88	UG/KG	NA		12.4017	100.00
598	B004	Lead (Pb)	229.00	MG/KG	NA		NA	
		Total			0.0617		12.4017	
598	B005	Antimony (Sb)	0.92	MG/KG	0.0315	100.00	NA	
598	B005	B(a)P Equiv.	754.97	UG/KG	NA		12.5025	100.00
598	B005	Lead (Pb)	1810.00	MG/KG	NA		NA	
		Total			0.0315		12.5025	
598	B006	Antimony (Sb)	2.20	MG/KG	0.0754	100.00	NA	
598	B006	B(a)P Equiv.	1395.06	UG/KG	NA		23.1026	100.00
598	B006	Lead (Pb)	272.00	MG/KG	NA		NA	
		Total			0.0754		23.1026	
599	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
599	B001	B(a)P Equiv.	20.30	UG/KG	NA		0.3362	100.00
599	B001	Lead (Pb)	27.50	MG/KG	NA		NA	
		Total			NA		0.3362	
599	B002	Antimony (Sb)	0.62	MG/KG	0.0213	100.00	NA	
599	B002	B(a)P Equiv.	117.16	UG/KG	NA		1.9402	100.00
599	B002	Lead (Pb)	423.00	MG/KG	NA		NA	
		Total			0.0213		1.9402	
599	B003	Antimony (Sb)	0.68	MG/KG	0.0233	100.00	NA	
599	B003	B(a)P Equiv.	1017.40	UG/KG	NA		16.8485	100.00
599	B003	Lead (Pb)	30.30	MG/KG	NA		NA	
		Total			0.0233		16.8485	
599	B004	Antimony (Sb)	0.71	MG/KG	0.0243	100.00	NA	
599	B004	B(a)P Equiv.	530.42	UG/KG	NA		8.7839	100.00
599	B004	Lead (Pb)	36.00	MG/KG	NA		NA	
		Total			0.0243		8.7839	

Table 10.47.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 598 and 599
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
599	B005	Antimony (Sb)	1.20	MG/KG	0.0411	100.00	NA	
599	B005	B(a)P Equiv.	471.16	UG/KG	NA		7.8026	100.00
599	B005	Lead (Pb)	233.00	MG/KG	NA		NA	
		Total			0.0411		7.8026	
599	B006	Antimony (Sb)	1.00	MG/KG	0.0343	100.00	NA	
599	B006	B(a)P Equiv.	452.33	UG/KG	NA		7.4907	100.00
599	B006	Lead (Pb)	206.00	MG/KG	NA		NA	
		Total			0.0343		7.4907	
599	B007	Antimony (Sb)	0.47	MG/KG	0.0161	100.00	NA	
599	B007	B(a)P Equiv.	24920.00	UG/KG	NA		412.6830	100.00
599	B007	Lead (Pb)	28.50	MG/KG	NA		NA	
		Total			0.0161		412.6830	

Table 10.47.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOCs 598 and 599
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
598	B001	B(a)P Equiv.	590.85	UG/KG	NA		1.9895	100.00
598	B001	Lead (Pb)	127.00	MG/KG	NA		NA	
		Total			NA		1.9895	
598	B002	B(a)P Equiv.	7095.00	UG/KG	NA		23.8899	100.00
598	B002	Lead (Pb)	212.00	MG/KG	NA		NA	
		Total			NA		23.8899	
598	B003	B(a)P Equiv.	609.83	UG/KG	NA		2.0534	100.00
598	B003	Lead (Pb)	60.30	MG/KG	NA		NA	
		Total			NA		2.0534	
598	B004	B(a)P Equiv.	748.88	UG/KG	NA		2.5216	100.00
598	B004	Lead (Pb)	229.00	MG/KG	NA		NA	
		Total			NA		2.5216	
598	B005	B(a)P Equiv.	754.97	UG/KG	NA		2.5421	100.00
598	B005	Lead (Pb)	1810.00	MG/KG	NA		NA	
		Total			NA		2.5421	
598	B006	B(a)P Equiv.	1395.06	UG/KG	NA		4.6974	100.00
598	B006	Lead (Pb)	272.00	MG/KG	NA		NA	
		Total			NA		4.6974	
599	B001	B(a)P Equiv.	20.30	UG/KG	NA		0.0684	100.00
599	B001	Lead (Pb)	27.50	MG/KG	NA		NA	
		Total			NA		0.0684	
599	B002	B(a)P Equiv.	117.16	UG/KG	NA		0.3945	100.00
599	B002	Lead (Pb)	423.00	MG/KG	NA		NA	
		Total			NA		0.3945	
599	B003	B(a)P Equiv.	1017.40	UG/KG	NA		3.4257	100.00
599	B003	Lead (Pb)	30.30	MG/KG	NA		NA	
		Total			NA		3.4257	
599	B004	B(a)P Equiv.	530.42	UG/KG	NA		1.7860	100.00
599	B004	Lead (Pb)	36.00	MG/KG	NA		NA	
		Total			NA		1.7860	
599	B005	B(a)P Equiv.	471.16	UG/KG	NA		1.5865	100.00
599	B005	Lead (Pb)	233.00	MG/KG	NA		NA	
		Total			NA		1.5865	

Table 10.47.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOCs 598 and 599
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
599	B006	B(a)P Equiv.	452.33	UG/KG	NA		1.5231	100.00
599	B006	Lead (Pb)	206.00	MG/KG	NA		NA	
		Total			NA		1.5231	
599	B007	B(a)P Equiv.	24920.00	UG/KG	NA		83.9091	100.00
599	B007	Lead (Pb)	28.50	MG/KG	NA		NA	
		Total			NA		83.9091	

Table 10.47.8.4
Chemicals Present in Site Samples
AOC 598 and AOC 599 - Shallow Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentratio	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics													
Aluminum (Al)		1	2	41.9	41.9	41.9	25	25	3700	2810	UG/L		
Arsenic (As)		1	2	9	9	9	5	5	0.045	18.7	UG/L	1	
Barium (Ba)	*	1	2	672	672	672	104	104	260	211	UG/L	1	1
Calcium (Ca)	N	1	2	362000	362000	362000	75800	75800	NA	NA	UG/L		
Cyanide (CN)		1	2	4.2	4.2	4.2	4	4	73	7.9	UG/L		
Iron (Fe)	N	2	2	12800	67100	39950	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	2	206000	206000	206000	49600	49600	NA	NA	UG/L		
Manganese (Mn)		1	2	187	187	187	274	274	84	2560	UG/L	1	
Nickel (Ni)		1	2	1.3	1.3	1.3	3.1	3.1	73	15.2	UG/L		
Potassium (K)	N	1	2	108000	108000	108000	43400	43400	NA	NA	UG/L		
Sodium (Na)	N	1	2	3110000	3110000	3110000	423000	423000	NA	NA	UG/L		
Vanadium (V)		2	2	1.7	2.5	2.1	NA	NA	26	10.6	UG/L		
Zinc (Zn)		1	2	16.1	16.1	16.1	8	8	1100	47.8	UG/L		
Pesticides													
Heptachlor	*	1	2	0.058	0.058	0.058	0.04	0.04	0.0023	NA	UG/L	1	
Semivolatile Organics													
Acenaphthene		1	2	4	4	4	10	10	220	NA	UG/L		
Benzoic acid		1	2	3	3	3	50	50	15000	NA	UG/L		
Fluorene		1	2	1	1	1	10	10	150	NA	UG/L		
4-Methylphenol		1	2	10	10	10	10	10	18	NA	UG/L		
Phenanthrene		1	2	1	1	1	10	10	150	NA	UG/L		

Notes:
* - Identified as a COPC
N - Essential Nutrient
UG/L - microgram per liter
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.47.8.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 598
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
598	G001	Barium (Ba)	672.00	UG/L	NA		0.6137	100.00
598	G001	Heptachlor	ND	UG/L	NA		NA	
		Total			NA		0.6137	
599	G001	Barium (Ba)	ND	UG/L	NA		NA	
599	G001	Heptachlor	0.06	UG/L	7.8067	100.00	0.0148	100.00
		Total			7.8067		0.0148	

10.47.9 Corrective Measures Considerations

For AOCs 598 and 599, the upper and lower soil intervals, sediment, and shallow groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. All soil samples were collected from beneath asphalt pavement.

BEQs were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 5E-05. The arithmetic mean risk is within USEPA's acceptable range of 1E-06 and 1E-04 for risk. BEQs were detected in 12 of 13 soil samples above a risk-based RGO of 0.06 mg/kg. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.47.9.1. Corrective measures for AOCs 598 and 599 are detailed in Section 9.

Lead was detected above USEPA's residential soil lead cleanup level of 400 mg/kg at two upper-interval soil samples collected from beneath the asphalt, 598SB005 and 599SB002. Additionally, BEQs exceed the RGO for these samples and corrective measures are being recommended.

Heptachlor epoxide was detected in the shallow groundwater above its risk-based RGO concentration of 0.000015 mg/L. The equated risk associated with heptachlor epoxide is 8E-06, which is between USEPA's acceptable range of 1E-06 to 1E-04. Corrective measures for heptachlor epoxide are presented in Table 10.47.9.1 and detailed in Section 9.

Table 10.47.9.1
Potential Corrective Measures for AOC 598 and AOC 599

Medium	Compounds	Potential Corrective Measures
Soil	BEQs and lead	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste
Shallow Groundwater	Heptachlor epoxide	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.48 AOC 602, Substation and Storage, Building 95

AOC 602 is a former electrical substation at Building 95. Constructed in 1943, Building 95 was originally used as an electrical substation for drydock 3. It housed PCB containing transformers until renovation in 1989. The renovation was interrupted by Hurricane Hugo and the building was subsequently taken out of service. Currently this area is paved with concrete/asphalt.

This site has not been investigated previously, but in 1986, fluid samples collected from the transformer indicated PCB concentrations were less than 50 ppm. During the RFA, stains were observed on the floor.

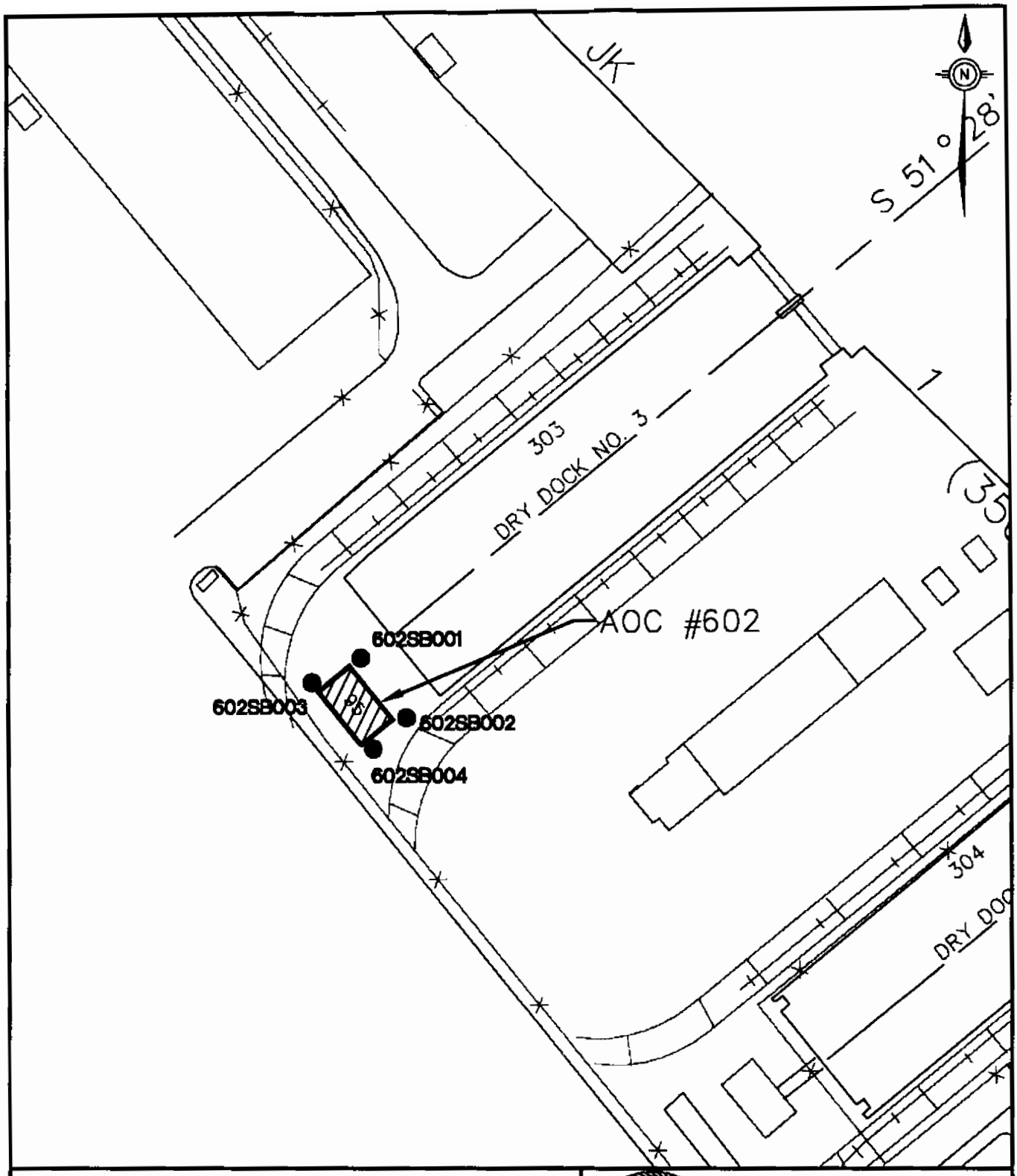
Dielectric fluid is the material of concern for AOC 602 identified in the *Final Zone E RFI Work Plan* . Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 602, soil and concrete surface wipe samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.48.1 Soil Sampling and Analysis

Soil samples were collected in one round at AOC 602 from the locations shown in Figure 10.48.1. The *Final Zone E RFI Work Plan*, proposed collecting 4 soil samples from the upper interval and four samples from the lower interval. All four proposed upper- and lower-interval samples were collected.

All samples were submitted for analysis at DQO Level III for PCBs. Additionally, one lower-interval sample was submitted for VOC analysis due to high OVA readings. Three upper-interval



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.48.1
SOIL BORING LOCATIONS
AOC #602
SUBSTATION
BUILDING 95

DWG DATE: 09/02/97 | DWG NAME: 10-48-1

samples selected for duplication were analyzed at DQO Level IV for Appendix IX analytical parameters which includes the suite of parameters proposed for the site, plus organophosphorus pesticides, herbicides, hexavalent chromium, and dioxins. Table 10.48.1.1 summarizes soil sampling at AOC 602.

Table 10.48.1.1
AOC 602
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	PCBs	PCBs	None
Lower	4	4	PCBs	PCBs	VOCs were collected from one sample due to OVA readings of 80 ppm.

10.48.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.48.2.1. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.48.2.1
AOC 602
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (µg/kg)						
Acetone	Lower	1/1	85.0	85.0	NA	NA
Methylene chloride	Lower	1/1	2.00	2.00	NA	NA

Table 10.48.2.1
AOC 602
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides/PCBs (µg/kg)						
Aroclor-1254	Upper	1/4	190	190	740	0
Aroclor-1260	Upper	1/4	210	210	740	0
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	3/3	0.133 - 0.590	0.366	1,000	0
1234678-HpCDD	Upper	3/3	6.34 - 21.6	11.7	NA	NA
123478-HxCDF	Upper	1/3	2.70	2.70	NA	NA
123678-HxCDF	Upper	1/3	1.23	1.23	NA	NA
234678-HxCDF	Upper	1/3	0.917	0.917	NA	NA
OCDD	Upper	3/3	42.0 - 159	87.6	NA	NA

Notes:
µg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Volatile Organic Compounds in Soil

Two VOCs — acetone and methylene chloride — were detected in soil samples collected at AOC 602. Both detections occurred in the lower interval; neither VOC exceeded its respective SSL.

Pesticides and PCBs in Soil

No pesticides were detected in soil samples submitted for laboratory analysis from AOC 602. Two PCBs — Aroclor-1254 and Aroclor-1260 — were detected in one of four upper-interval soil samples collected at AOC 602. Neither PCB exceeded its respective industrial RBC.

Other Organic Compounds in Soil

Five dioxins were detected in soil samples collected at AOC 602. Nine detections occurred in the upper interval and zero in the lower interval. No industrial RBCs have been established for the detected dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated. The upper-interval TEQ was calculated for three samples with a range of 0.133 to 0.590 ng/kg and a mean of 0.366 ng/kg. The calculated TEQ was below the industrial RBC of 1,000 ng/kg.

10.48.3 Wipe Sampling and Analysis

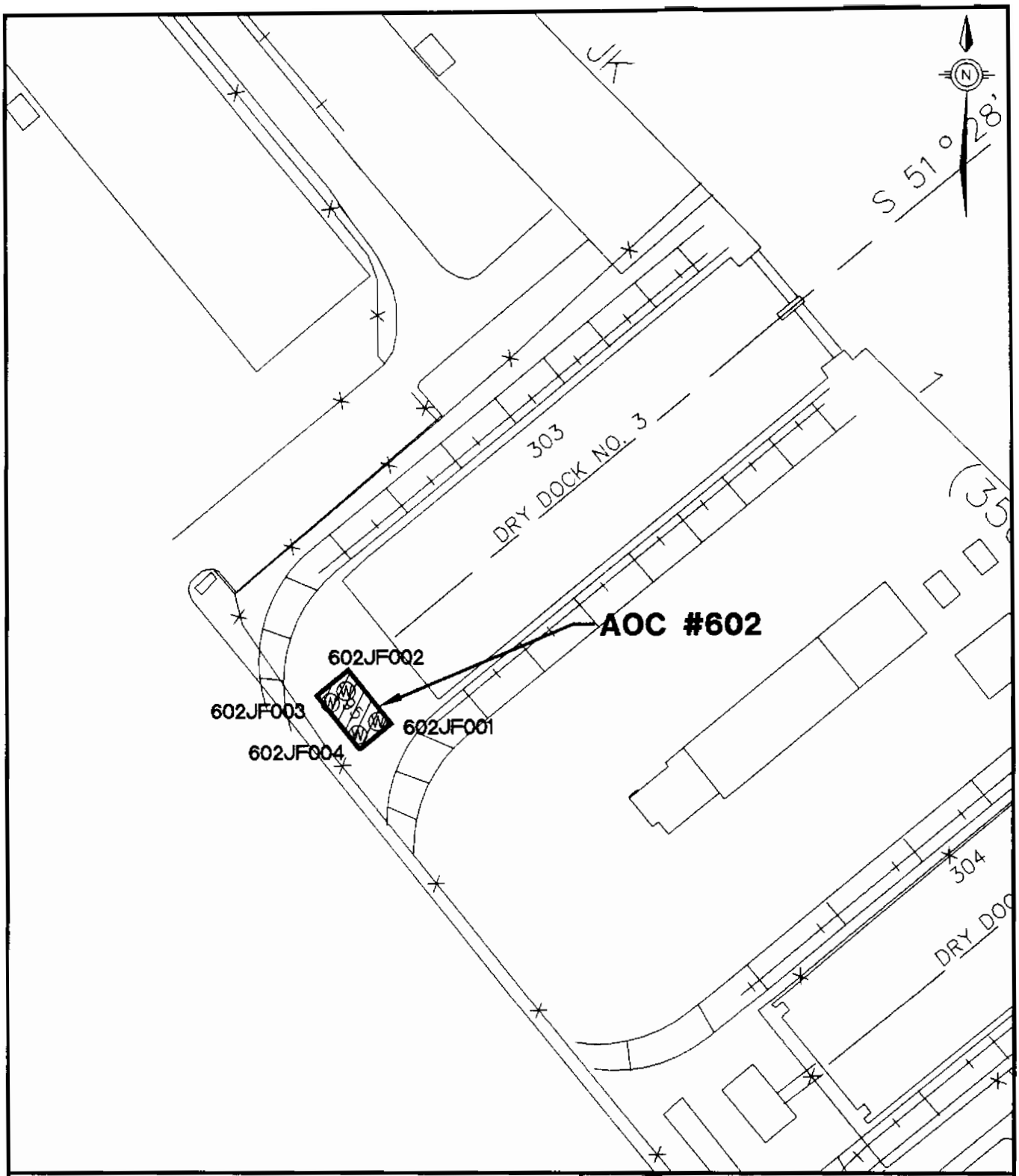
Concrete surfaces were sampled at AOC 602 from the locations shown in Figure 10.48.2. The *Final Zone E RFI Work Plan* proposed the collection of four wipe samples at AOC 602. All four samples were collected and submitted for PCB analysis. Table 10.48.3.1 summarizes wipe sampling activity for AOC 602.

Table 10.48.3.1
AOC 602
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
4	4	PCB	PCB	None

10.48.4 Nature of Contamination in Dust

Table 10.48.4.1 summarizes the wipe sample analytical results for AOC 602. Sample locations were determined in the field and were biased in an attempt to identify worst case situations. Sample locations were selected based on the location of PCB-containing equipment and visual evidence of spills and leaks.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.48.2
WIPE SAMPLE LOCATIONS
AOC #602
SUBSTATION
BUILDING 95

DWG DATE: 09/02/97 | DWG NAME: 10-48-2

Table 10.48.4.1
AOC 602
Wipe Sampling Analytical Results

Frequency of Detection	Parameter	Range of Detections (μg/wipe)
0/4	PCB	ND

Notes:
$\mu g/100\ cm^2$ = micrograms per 100 square centimeters
ND = not detected

PCBs Detected on Surfaces

Four wipe samples were collected at AOC 602 and analyzed for PCBs. No PCBs were detected.

10.48.5 Fate and Transport Assessment for AOC 602

AOC 602 is a former electrical substation at Building 95. The area around the building is paved with concrete and asphalt. Samples collected as part of the AOC 602 CSI included surface soil, subsurface soil, and wipe samples. Because PCBs were the focus of the investigation, the majority of the samples were only analyzed for PCBs. The potential constituent migration pathway investigated for AOC 602 is soil to groundwater. The emission of volatiles from the surface soil to air pathway was not assessed since no VOCs were detected in surface soil samples.

10.48.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.48.3.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No constituents were detected in AOC 602 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. As a result, the soil-to-groundwater migration pathway is not expected to be a viable pathway at AOC 602. Since no constituents exceeded first-tier screening criteria for soil, a second-tier comparison was not necessary or performed at AOC 602.

10.48.5.2 Fate and Transport Summary

No constituents were detected in surface or subsurface soil at concentrations exceeding any of the first-tier soil screening levels. Therefore, no threat was identified to ambient air, groundwater, or surface water in the Cooper River via the evaluated migration pathways.

Table 10.48.5.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 602
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *					Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units			
Volatile Organic Compounds												
Acetone	NA	85	NA	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	NA	2	NA	NA	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1254	190	ND	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
Aroclor-1260	210	ND	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.59	NA	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

10.48.6 Fixed-Point Risk Evaluation for AOC 602

10.48.6.1 Site Background and Investigative Approach

AOC 602 is a former electrical substation located in Building 95. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment is presented as a FRE following the framework presented in Section 7.3.

All four surface soil samples collected during the AOC 602 CSI were considered in the FRE. Groundwater investigation was not part of the CSI sampling activities for this site. Sections 10.48.1 contains a summary of the soil sampling effort for AOC 602.

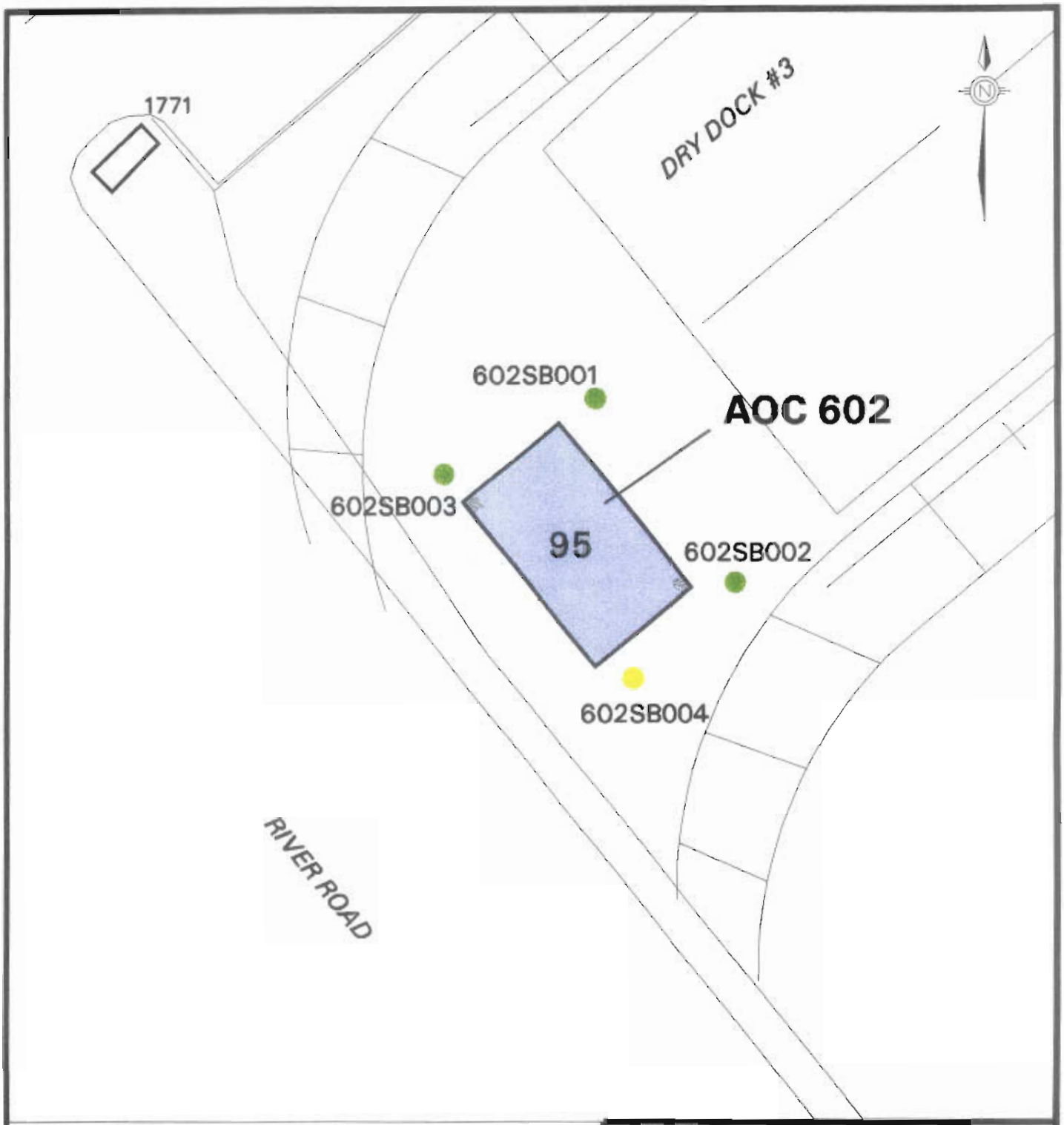
10.48.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.48.6.1 provides CPSS summaries for AOC 602 surface soil and identifies COPCs based on comparison to residential and industrial RBCs, and background RCs. Based on residential RBCs, Aroclor-1254 and Aroclor-1260 were identified as COPCs for AOC 602.

Table 10.48.6.2 summarizes the residential COPCs detected at each AOC 602 sample location with contribution to risk and hazard. As shown, Aroclor-1254 and Aroclor-1260 contribute to risk estimates for AOC 602 surface soil, exceeding 1E-06 at only one of four sample locations. Figure 10.48.3 is a spatial presentation of residential risk estimates for AOC 602 surface soil. The risk estimate for 602SB004, the only sample in which detectable concentrations of PCBs were reported, was 2E-06. Assuming a deminimus risk value of 1E-07 in samples where no PCBs were reported, the arithmetic mean risk for AOC 602 is 5E-07.

Aroclor-1254 also contributed to HI estimates, which did not exceed unity at any of the four sample locations. The hazard estimate for 602SB004 was 0.2.


1771
DRY DOCK #3
602SB001
AOC 602
602SB003
95
602SB002
602SB004
RIVER ROAD
LEGEND - CUMULATIVE SOIL RISK
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.48.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 602

Industrial Scenario

No COPCs were identified in AOC 602 surface soil based on industrial RBCs.

10.48.6.3 Uncertainty

AOC 602 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Quantification of Risk/Hazard

A conservative screening process was used to identify COPCs for AOC 602. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For

carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

10.48.6.4 FRE Summary

The risk and hazard posed by contaminants at AOC 602 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. Risk and HI estimates are presented on Table 10.48.6.2, such that risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Neither Aroclor-1254 nor Aroclor-1260 were detected in AOC 602 surface soil at concentrations above their residential RGOs, however in one of four samples the combined risk associated with these PCB Aroclors was estimated to be 2E-06.

Aroclor-1254 was detected in AOC 590 surface soil at a concentration above its hazard-based RBC benchmark, but the HI did not exceed unity at any of the four sample locations.

Soil — Site Worker Scenario

No COPCs were detected in AOC 590 surface soil at concentrations above their industrial risk or hazard-based RGOs.

Table 10.48.6.1
Chemicals Present is Site Samples
AOC 602 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res.	Ind.	Ref.
PCBs															
Aroclor-1260	*	1	4	210	210	210	78	82	83	740	NA	UG/KG	1		
Aroclor-1254	*	1	4	190	190	190	78	82	83	740	NA	UG/KG	1		
TCDD Equivalents															
Dioxin Equiv.		3	3	0.133	0.5901	0.366	NA	NA	1000	1000	NA	NG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.48.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 602
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
602	B001	Aroclor-1254	ND	UG/KG	NA		NA	
602	B001	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
602	B002	Aroclor-1254	ND	UG/KG	NA		NA	
602	B002	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
602	B003	Aroclor-1254	ND	UG/KG	NA		NA	
602	B003	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
602	B004	Aroclor-1254	190.00	UG/KG	0.1567	100.00	0.8620	47.50
602	B004	Aroclor-1260	210.00	UG/KG	NA		0.9528	52.50
		Total			0.1567		1.8148	

10.48.7 Corrective Measures Considerations

For AOC 602, the upper and lower soil intervals were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for upper soil interval. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. All soil samples was collected from beneath the asphalt pavement.

Aroclors 1254 and 1260 were identified as COCs in the upper soil interval. The soil pathway residential arithmetic mean exposure risk is 5E-07, which does not exceed USEPA's acceptable risk of 1E-06. Aroclors 1254 and 1260 were detected in one of four soil samples above their risk-based RGO of 0.22 mg/kg each, based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.48.7.1. Corrective measures for AOC 602 are detailed in Section 9.

Table 10.48.7.1
Potential Corrective Measures for AOC 602

Medium	Compounds	Potential Corrective Measures
Soil	Aroclors 1254 and 1260	a) No Action b) Intrinsic Remediation and Monitoring c) Containment by Capping d) Excavation and Landfill, if RCRA-nonhazardous Waste

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10.49 AOC 604, Substation and Storage, Building 96

AOC 604 is a former electrical substation at Building 96. Constructed in 1946, Building 95 was originally used as an electrical substation for drydock 4. It originally housed PCB containing transformers. The electrical items currently stored in Building 96 do not contain PCBs. Two permanent transformers, and one temporary transformer are currently located adjacent to Building 96. This site has not been investigated previously. However, during the RFA, stained soil from a small leak in the transformer was observed.

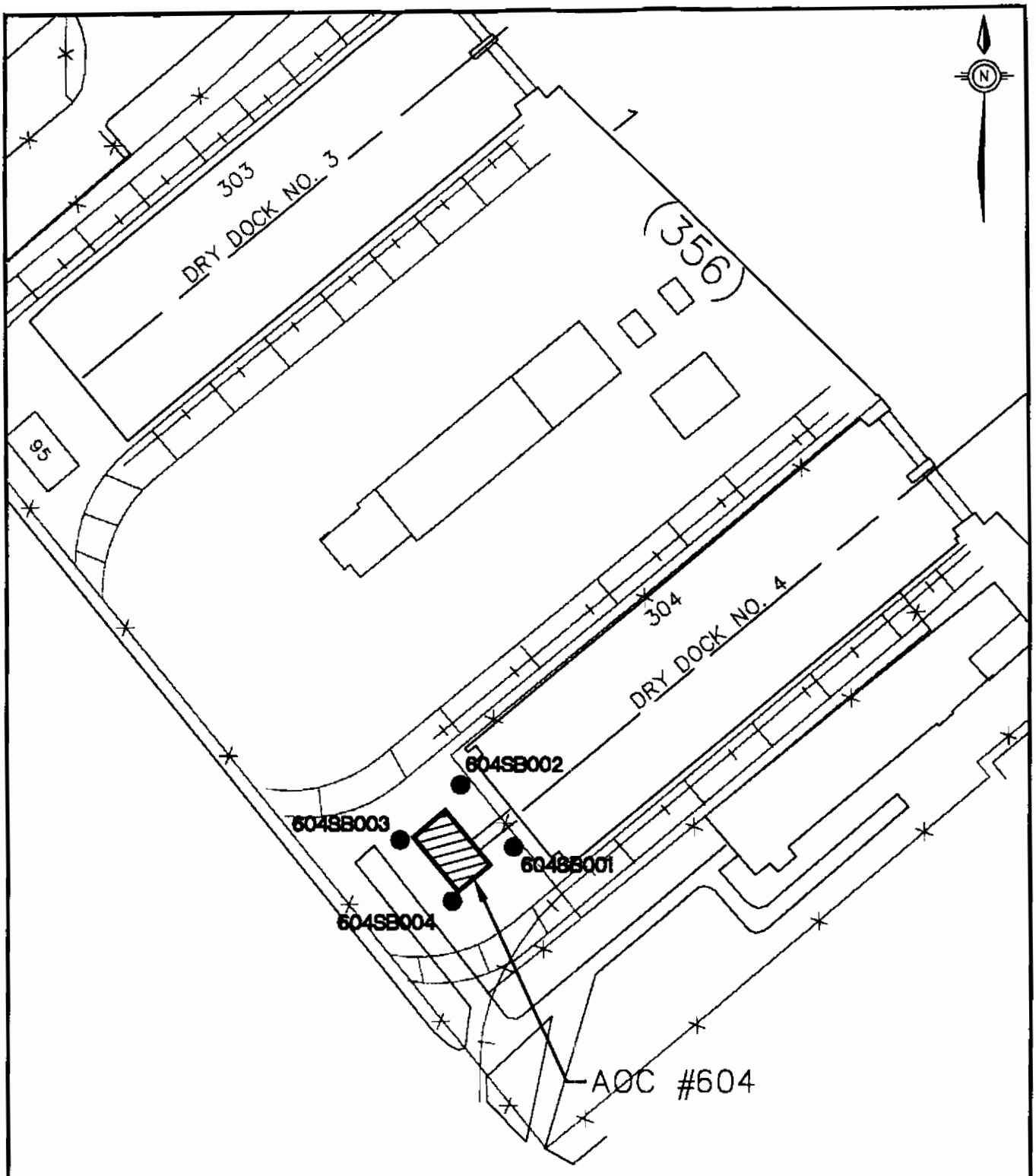
Dielectric fluid is the material of concern for AOC 604 identified in the *Final Zone E RFI Work Plan* . Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 604, soil and concrete surface wipe samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.49.1 Soil Sampling and Analysis

Soil was sampled in one round at AOC 604 from the locations shown in Figure 10.49.1. The *Final Zone E RFI Work Plan*, proposed collecting four soil samples from the upper interval and four samples from the lower interval. All four of the proposed upper-interval and lower-interval samples were collected.

All samples were submitted for PCB analysis at DQO Level III. In addition, two samples (one upper-interval and one lower-interval) were submitted for VOC analysis, and two samples (one upper-interval and one lower-interval) were submitted for TPH analysis due to high OVA readings and petroleum odor in the sample. No samples were selected as duplicates at AOC 604. Table 10.49.1.1 summarizes soil sampling at AOC 604.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.49.1
SOIL BORING LOCATIONS
AOC #604
SUBSTATION
BUILDING 96

DWG DATE: 09/02/97 | DWG NAME: 10-49-1

Table 10.49.1.1
AOC 604
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	PCBs	PCBs	One sample submitted for VOC analysis, and one sample submitted for TPH analysis
Lower	4	4	PCBs	PCBs	One sample submitted for VOC analysis, and one sample submitted for TPH analysis

10.49.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.49.2.1. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.49.2.1
AOC 604
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (µg/kg)						
Acetone	Upper	1/1	90.0	90.0	20,000,000	0
	Lower	1/1	110	110	NA	NA
Xylene (Total)	Upper	1/1	2.00	2.00	100,000,000	0
PCBs (µg/kg)						
Aroclor-1254	Upper	2/4	8.90 - 17.0	13.0	740	0
TPH (mg/kg)						
Gasoline	Upper	1/1	3,800	3,800	NA	NA
Kerosene	Upper	1/1	1,610	1,610	NA	NA
	Lower	1/1	17.3	17.3	NA	NA

Notes:
µg/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Volatile Organic Compounds in Soil

Two VOCs were detected in soil samples collected at AOC 604. Two detections occurred in the upper interval and one occurred in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

PCBs in Soil

One PCB — Aroclor-1254 — was detected in two of four upper-interval soil samples at AOC 604. The PCB did not exceed its respective industrial RBC in the upper interval.

Other Organic Compounds in Soil

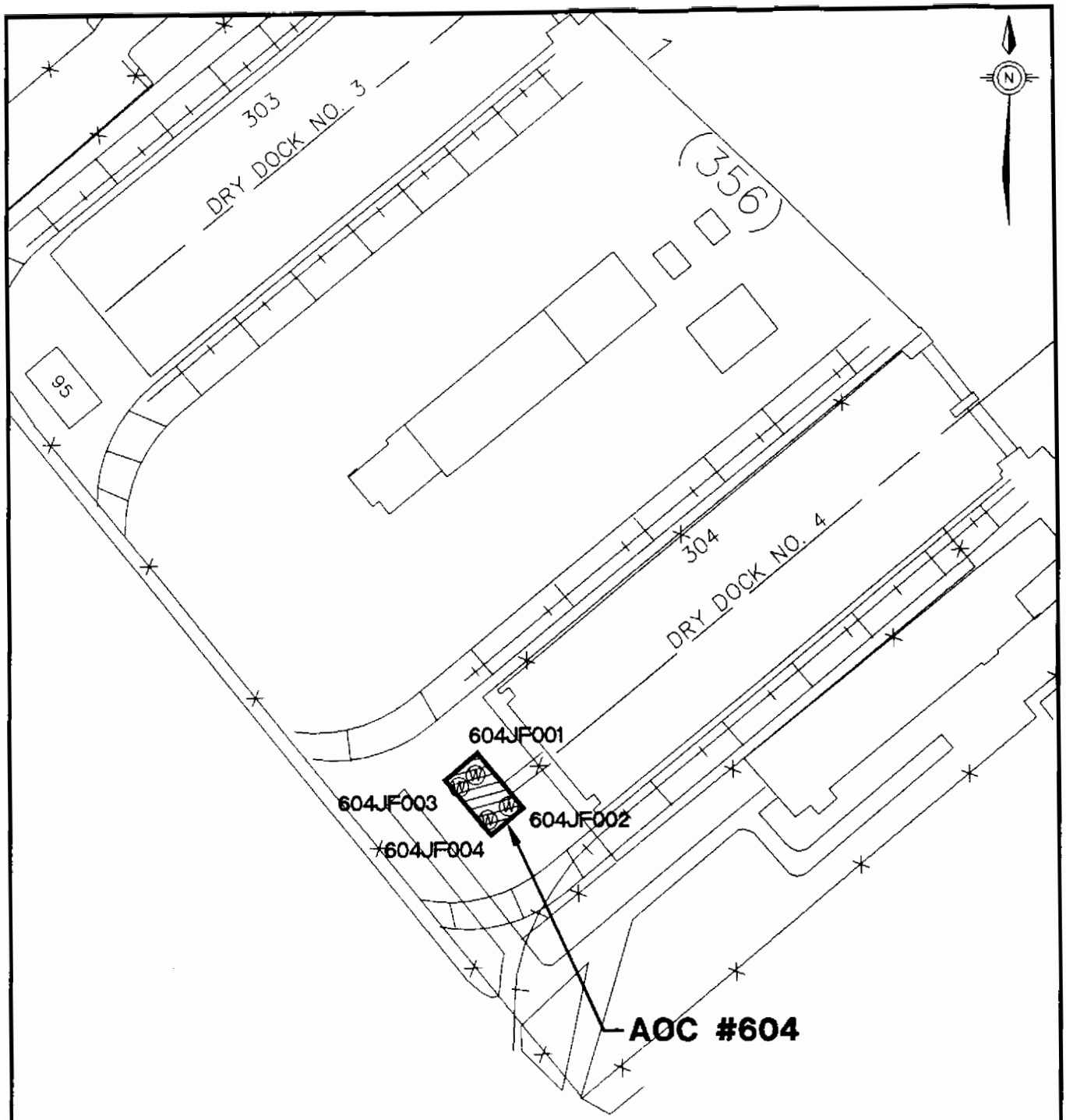
TPH-gasoline was detected in one upper-interval sample collected at AOC 604. TPH-kerosene was detected in one upper-interval sample and one lower-interval sample. No industrial RBC or SSL has been established for TPH in soil.

10.49.3 Wipe Sampling and Analysis

Concrete surfaces were sampled at AOC 604 from the locations shown in Figure 10.49.2. The *Final Zone E RFI Work Plan* proposed the collection of four wipe samples at AOC 604. All four samples were collected and submitted for PCB analysis. Table 10.49.3.1 summarizes wipe sampling activity for AOC 604.

Table 10.49.3.1
AOC 604
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
4	4	PCB	PCB	No deviation from proposed



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.49.2
WIPE SAMPLE LOCATIONS
AOC #604
SUBSTATION
BUILDING 96

DWG DATE: 09/02/97 | DWG NAME: 10-49-2

10.49.4 Nature of Contamination in Dust

Table 10.49.4.1 summarizes the wipe sample analytical results for AOC 604. Sample locations were determined in the field and were biased in an attempt to identify worst case situations. Sample locations were selected based on the location of PCB-containing equipment and visual evidence of spills and leaks.

Table 10.49.4.1
AOC 604
Wipe Sampling Analytical Results

Parameter	Frequency of Detection	Range of Detections (μg/wipe)
PCB	3/4	0.59 - 3.2

Note:
μg/100 cm^2 = micrograms per 100 square centimeters

PCBs Detected on Surfaces

PCBs were detected in three of four samples with a range 0.59 to 3.2 ug\ 100 cm^2. No residential or industrial RBCs exist for wipe samples.

10.49.5 Fate and Transport Assessment for AOC 604

AOC 604 is a former electrical substation at Building 96. The area around the building is primarily concrete and asphalt pavement. Samples collected as part of the AOC 604 CSI included surface soil, subsurface soil, and wipe samples. Because PCBs were the focus of the investigation, the majority of the samples were only analyzed for PCBs. The potential constituent migration pathways investigated for AOC 604 include soil to groundwater and emission of volatiles from surface soil to air.

10.49.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.49.3.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No constituents were detected in AOC 604 surface or subsurface soil at concentrations exceeding generic groundwater protection SSLs. As a result, the soil-to-groundwater migration pathway is not expected to be a viable pathway at AOC 604. Since no constituents exceeded first-tier screening criteria for soil, a second-tier comparison was not necessary or performed at AOC 604.

10.49.5.2 Soil-to-Air Cross-Media Transport

Table 10.45.5.2 lists the two VOCs detected in surface soil samples collected at AOC 604 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at AOC 604. In addition, neither VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 604.

10.49.5.3 Fate and Transport Summary

No constituents were detected in surface or subsurface soil at concentrations exceeding any of the first-tier soil screening levels. Therefore, no threat was identified to ambient air, groundwater, or surface water in the Cooper River via the evaluated migration pathways.

Table 10.49.5.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 604
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	90	110	NA	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	2	ND	NA	NA	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1254	17	ND	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
TPH - Diesel Range Organics												
Kerosene	1610	17.3	NA	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
TPH - Gasoline Range Organics												
Gasoline	3800	ND	NA	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.49.5.2
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 604
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	90	62000000	UG/KG	NO
Xylene (total)	2	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.49.6 Fixed-Point Risk Evaluation for AOC 604

10.49.6.1 Site Background and Investigative Approach

AOC 604 is a former electrical substation and storage area located in Building 96. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment is presented as a FRE following the framework presented in Section 7.3.

All four surface soil samples collected during the AOC 604 CSI were considered in the FRE. Groundwater investigation was not part of the CSI sampling activities for this site. Sections 10.49.1 contains a summary of the soil sampling effort for AOC 604.

10.49.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.49.6.1 provides CPSS summaries for AOC 604 surface soil and identifies COPCs based on comparison to residential and industrial RBCs, and background RCs. Based on residential RBCs, no COPCs were identified in surface soils at AOC 604.

Industrial Scenario

No COPCs were identified in AOC 604 surface soil based on industrial RBCs.

10.49.6.3 Uncertainty

AOC 604 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA

Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Quantification of Risk/Hazard

A conservative screening process was used to identify COPCs for AOC 604. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

10.49.6.4 FRE Summary

No COPCs were identified at AOC 604; therefore, risk and hazard was not formally assessed.

Table 10.49.6.1
Chemical Present in Site Samples
AOC 604 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res.	Number Exceeding Ind.	Number Exceeding Ref.
PCBs														
Aroclor-1254	2	4	8.9	17	12.95	82	82	83	740	NA	UG/KG			
Total Petroleum Hydrocarbons														
Gasoline	1	1	3800	3800	3800	NA	NA	NA	NA	NA	UG/KG			
Kerosene	1	1	1610	1610	1610	NA	NA	NA	NA	NA	MG/KG			
Volatile Organics														
Acetone	1	1	90	90	90	NA	NA	780000	20000000	NA	UG/KG			
Xylene (Total)	1	1	2	2	2	NA	NA	16000000	100000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

10.49.7 Corrective Measures Considerations

No COPCs were identified at AOC 604, therefore, corrective measures were not considered for this site.

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10.50 Supplemental Sampling

To help characterize background conditions and provide data points where site-specific data are missing, supplemental soil and groundwater sampling was proposed throughout Zone E. A series of shallow and deep groundwater monitoring well pairs were distributed across Zone E, complementing the sample locations designated in the site-specific investigations. Usable data from sample locations near AOCs and SWMUs were incorporated into the appropriate site assessments if it appeared that these locations had been impacted by the site activities. If the SWMU or AOC had no impact on its associated supplemental sample location, the location was used to determine background levels used in the site-specific evaluations for groundwater.

To accomplish this objective, soil and groundwater samples were collected from a biased distribution of 30 shallow and deep monitoring well pairs in accordance with the *Final Zone E RFI Work Plan* (E/A&H, June 1995) and Section 3 of this report. The sample locations were chosen based on a number of variables including: the suspected direction of groundwater flow, suspected location of subsurface utilities, suspected location of piling supports, density of site-specific sample locations, and the proximity to the Cooper River.

10.50.1 Soil Sampling and Analysis

Soil was sampled in one round at the supplemental shallow monitoring well locations shown in Figure 10.50.1. The *Final Zone E RFI Work Plan* (E/A&H, June 1995), proposed collecting 25 soil samples from the upper interval and 25 samples from the lower interval at the shallow well locations. Soil samples were also collected at both intervals from five additional supplemental shallow well locations (NBCEGDE026 through NBCEGDE030), added to the originally proposed locations to further characterize Zone E groundwater.

All 30 of the proposed upper-interval samples and 28 of 30 proposed lower-interval samples were collected. Two lower-interval samples could not be collected due to subsurface obstructions such as rocks or wood.

Samples from the initial 25 proposed well locations were submitted for analysis at DQO Level III for the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. The five additional well locations were analyzed for SVOCs and metals. In addition, one sample was also submitted for TPH analysis due to elevated OVA readings. Nine samples were selected as duplicates and were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the suite of parameters originally proposed, plus a more comprehensive list of VOCs, SVOCs, as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.50.1 summarizes soil sampling at supplemental shallow well locations.

Table 10.50.1
Supplemental Sampling
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	30	30	Standard Suite[a]	Standard Suite[a]	None
Lower	30	28	Standard Suite[a]	Standard Suite[a]	Subsurface obstructions prevented the collection of two samples

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCBs

10.50.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.50.2.1. Inorganic analytical results soil are summarized in Table 10.50.2.2. Appendix H is the complete data report for all samples collected in Zone E.

Table 10.50.2.1
Supplemental Sampling
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (µg/kg)						
Acetone	Upper	14/25	12.0 - 5,800	465	20,000,000	0
	Lower	12/24	9.00 - 160	47.6	NA	NA
2-Butanone (MEK)	Upper	2/25	10.0 - 17.0	13.5	100,000,000	0
Carbon disulfide	Upper	1/25	12.0	12.0	20,000,000	0
	Lower	1/24	3.00	3.00	NA	NA
Methylene chloride	Upper	3/25	4.00 - 9.00	6.00	760,000	0
	Lower	2/24	11.0 - 14.0	12.5	NA	NA
Toluene	Upper	1/25	2.00	2.00	41,000,000	0
1,1,1-Trichloroethane	Upper	1/25	3.00	3.00	7,200,000	0
Trichlorofluoromethane	Lower	1/3	3.00	3.00	NA	NA
Xylene (Total)	Upper	2/25	1.000 - 2.00	1.50	100,000,000	0
SVOCs (µg/kg)						
Anthracene	Upper	6/30	64.0 - 3,000	592	61,000,000	0
	Lower	4/28	70.0 - 640	278	NA	NA
Benzo(g,h,i)perylene	Upper	16/30	58.0 - 1,500	274	8,200,000	0
	Lower	8/28	73.0 - 1,800	448	NA	NA
Benzoic acid	Upper	8/30	56.0 - 1,800	322	100,000,000	0
	Lower	7/28	58.0 - 220	118	NA	NA
Benzyl alcohol	Upper	1/30	380	380	61,000,000	0

Table 10.50.2.1
Supplemental Sampling
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (µg/kg)						
bis(2-Ethylhexyl)phthalate	Upper	6/30	50.0 - 1,700	460	410,000	0
	Lower	6/28	180 - 720	370	NA	NA
Butylbenzylphthalate	Upper	3/30	95.0 - 2,200	832	41,000,000	0
	Lower	2/28	200 - 380	290	NA	NA
Carbazole	Upper	2/6	100 - 470	285	290,000	0
4-Chloro-3-methylphenol	Upper	2/30	42.0 - 120	81.0	NA	NA
Dibenzofuran	Upper	2/30	120 - 190	155	820,000	0
	Lower	1/28	140	140	NA	NA
Di-n-butylphthalate	Upper	2/30	44.0 - 76.0	60.0	20,000,000	0
	Upper	1/30	51.0	51.0	4,100,000	0
Fluoranthene	Upper	18/30	51.0 - 5,700	713	8,200,000	0
	Lower	12/28	86.0 - 4,800	836	NA	NA
Fluorene	Upper	4/30	39.0 - 1,500	465	8,200,000	0
	Lower	4/28	46.0 - 270	122	NA	NA
2-Methylnaphthalene	Upper	1/30	570	570	8,200,000	0
Naphthalene	Upper	1/30	120	120	8,200,000	0
	Lower	1/28	71.0	71.0	NA	NA
4-Nitrophenol	Upper	2/30	44.0 - 110	77.0	13,000,000	0
Pentachlorophenol	Upper	2/30	51.0 - 120	85.5	48,000	0
Phenanthrene	Upper	14/30	38.0 - 10,000	931	8,200,000	0
	Lower	9/28	93.0 - 2,500	567	NA	NA
Pyrene	Upper	19/30	50.0 - 7,800	781	6,100,000	0
	Lower	11/28	130 - 7,700	1,220	NA	NA

Table 10.50.2.1
Supplemental Sampling
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	16/30	0.0640 - 4,990	629	780	4
	Lower	11/28	0.0850 - 4,170	758	NA	NA
Benzo(a)anthracene	Upper	13/30	62.0 - 4,200	599	7,800	0
	Lower	8/28	130 - 3,400	800	NA	NA
Benzo(b)fluoranthene	Upper	12/30	69.0 - 2,300	419	7,800	0
	Lower	7/28	120 - 2,600	623	NA	NA
Chrysene	Upper	15/30	64.0 - 4,700	625	780,000	0
	Lower	9/28	85.0 - 3,400	737	NA	NA
Dibenz(a,h)anthracene	Upper	6/30	58.0 - 1,100	278	780	1
	Lower	4/28	160 - 780	348	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	12/30	58.0 - 1,200	276	7,800	0
	Lower	6/28	83.0 - 1,600	498	NA	NA
Benzo(k)fluoranthene	Upper	13/30	85.0 - 1,300	402	78,000	0
	Lower	8/28	92.0 - 2,300	646	NA	NA
Benzo(a)pyrene	Upper	15/30	82.0 - 3,100	449	780	1
	Lower	9/28	120 - 2,600	612	NA	NA
Pesticides/PCBs (μg/kg)						
Aldrin	Upper	1/25	2.80	2.80	340	0
alpha-Chlordane	Upper	2/25	4.90 - 5.40	5.15	2,200	0
	Lower	1/24	33.0	33.0	NA	NA
gamma-Chlordane	Upper	2/25	1.60 - 6.20	3.90	2,200	0
	Lower	1/24	34.0	34.0	NA	NA
4,4'-DDD	Upper	3/25	9.50 - 30.0	18.2	24,000	0
	Lower	3/24	3.50 - 12.0	7.97	NA	NA

Table 10.50.2.1
Supplemental Sampling
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides/PCBs (μg/kg)						
4,4'-DDE	Upper	7/25	3.00 - 110	25.8	17,000	0
	Lower	3/24	6.10 - 380	134	NA	NA
4,4'-DDT	Upper	7/25	3.00 - 79.0	17.9	17,000	0
	Lower	3/24	6.10 - 140	55.4	NA	NA
Dieldrin	Upper	2/25	4.50 - 7.50	6.00	360	0
	Lower	2/24	4.90 - 10.0	7.45	NA	NA
Endrin	Upper	1/25	63.0	63.0	61,000	0
	Lower	2/24	6.60 - 8.10	7.35	NA	NA
Endrin aldehyde	Upper	2/25	3.20 - 3.60	3.40	61,000	0
	Lower	1/24	6.60	6.60	NA	NA
Endrin ketone	Upper	1/25	16.0	16.0	61,000	0
Heptachlor	Upper	1/25	3.00	3.00	1,300	0
	Lower	1/24	1.40	1.40	NA	NA
Aroclor-1254	Upper	1/25	54.0	54.0	740	0
	Lower	1/24	520	520	NA	NA
Aroclor-1260	Upper	2/25	76.0 - 360	218	740	0
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	6/6	0.00660 - 0.799	0.335	1,000	0
	Lower	3/3	0.0307 - 0.523	0.202	NA	NA
1234678-HpCDD	Upper	5/6	3.08 - 11.9	6.53	NA	NA
	Lower	2/3	2.47 - 13.9	8.18	NA	NA
1234678-HpCDF	Upper	4/6	0.765 - 8.81	4.31	NA	NA
	Lower	2/3	0.886 - 2.09	1.49	NA	NA
123678-HxCDD	Upper	1/6	0.528	0.528	NA	NA

Table 10.50.2.1
Supplemental Sampling
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
123478-HxCDF	Upper	1/6	2.09	2.09	NA	NA
	Lower	1/3	1.97	1.97	NA	NA
123678-HxCDF	Upper	2/6	2.45 - 4.38	3.41	NA	NA
234678-HxCDF	Upper	2/6	0.733 - 1.09	0.911	NA	NA
OCDD	Upper	6/6	6.64 - 128	61.0	NA	NA
	Lower	3/3	6.71 - 184	69.3	NA	NA
OCDF	Upper	4/6	0.759 - 6.35	4.06	NA	NA
	Lower	3/3	2.02 - 3.40	2.85	NA	NA
Engineering Parameters (SV)						
pH	Upper	1/1	8.37	8.37	NA	NA

Notes:
µg/kg = Micrograms per kilogra
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established
SV = Standard units

Table 10.50.2.2
Supplemental Sampling
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	RC	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Aluminum (Al)	Upper	25/30	1,950 - 20,500	7,670	100,000	26,600	0
	Lower	24/28	1,220 - 29,900	8,780	NA	41,100	NA

Table 10.50.2.2
Supplemental Sampling
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	RC	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Antimony (Sb)	Upper	10/30	0.500 - 7.40	1.74	82.0	1.77	0
	Lower	8/28	0.600 - 1.60	0.935	NA	1.60	NA
Arsenic (As)	Upper	23/30	1.30 - 67.5	12.1	3.80	23.9	13
	Lower	23/28	0.830 - 29.4	9.50	NA	19.9	NA
Barium (Ba)	Upper	25/30	5.70 - 1980	108	14,000	130	0
	Lower	24/28	6.10 - 91.0	26.6	NA	94.1	NA
Beryllium (Be)	Upper	21/30	0.140 - 1.60	0.595	1.30	1.70	0
	Lower	23/28	0.150 - 1.60	0.577	NA	2.71	NA
Cadmium (Cd)	Upper	11/30	0.230 - 1.50	0.771	100	1.50	0
	Lower	11/28	0.130 - 0.960	0.537	NA	0.960	NA
Calcium (Ca)	Upper	25/30	218 - 60,500	16,200	NA	NA	NA
	Lower	24/28	323 - 239,000	33,300	NA	NA	NA
Chromium (Cr)	Upper	29/30	2.30 - 567	38.4	1,000	94.6	0
	Lower	27/28	1.60 - 84.8	22.1	NA	75.2	NA
Cobalt (Co)	Upper	25/30	0.870 - 111	9.05	12,000	19.0	0
	Lower	24/28	0.410 - 14.9	3.78	NA	14.9	NA
Copper (Cu)	Upper	25/30	0.760 - 866	87.4	8,200	66.0	0
	Lower	24/28	1.30 - 192	29.3	NA	152	NA
Cyanide (CN)	Upper	3/25	0.290 - 0.750	0.447	4,100	0.500	0
	Lower	2/24	0.370 - 0.770	0.570	NA	NA	NA
Iron (Fe)	Upper	25/30	1090 - 30,600	10,900	61,000	NA	0
	Lower	24/28	924 - 35,800	10,500	NA	NA	NA
Lead (Pb)	Upper	25/30	2.20 - 400	87.5	1,300	265	0
	Lower	24/28	1.80 - 322	52.0	NA	173	NA

Table 10.50.2.2
Supplemental Sampling
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	RC	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Magnesium (Mg)	Upper	25/30	75.7 - 14,800	1,920	NA	NA	NA
	Lower	24/28	76.5 - 9,140	2,070	NA	NA	NA
Manganese (Mn)	Upper	25/30	6.80 - 508	132	4,700	302	0
	Lower	24/28	4.90 - 625	117	NA	881	NA
Mercury (Hg)	Upper	23/30	0.0300 - 2.70	0.340	61	2.60	0
	Lower	20/28	0.0400 - 0.900	0.201	NA	1.59	NA
Nickel (Ni)	Upper	24/30	2.00 - 71.5	14.3	4,100	77.1	0
	Lower	23/28	0.850 - 23.7	8.38	NA	57.0	NA
Potassium (K)	Upper	19/30	249 - 2,620	848	NA	NA	NA
	Lower	18/28	106 - 3,440	1,270	NA	NA	NA
Selenium (Se)	Upper	10/30	0.570 - 1.70	1.01	1,000	1.70	0
	Lower	7/28	0.590 - 2.40	1.30	NA	2.40	NA
Silver (Ag)	Upper	2/30	0.750 - 0.910	0.830	1,000	NA	0
Sodium (Na)	Upper	22/30	11.9 - 438	216	NA	NA	NA
	Lower	21/28	20.8 - 1,430	491	NA	NA	NA
Thallium (Tl)	Upper	4/30	0.620 - 2.80	1.57	16	2.80	0
Tin (Sn)	Upper	13/30	2.90 - 44.7	14.6	6,100	59.4	0
	Lower	13/28	2.80 - 23.9	6.05	NA	9.23	NA
Vanadium (V)	Upper	26/30	2.50 - 60.1	17.8	1,400	94.3	0
	Lower	25/28	1.60 - 71.4	22.8	NA	155	NA
Zinc (Zn)	Upper	25/30	3.90 - 855	183	61,000	827	0
	Lower	24/28	5.80 - 438	97.2	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC established

Volatile Organic Compounds in Soil

Eight VOCs were detected in soil samples collected at supplemental sample locations. Twenty-four detections occurred in the upper interval and sixteen in the lower interval. No VOC exceeded its respective industrial RBC.

Semivolatile Organic Compounds in Soil

Twenty-five SVOCs were detected in soil samples collected at supplemental sample locations. One hundred and ninety-six detections occurred in the upper interval and 116 in the lower interval. Two SVOCs — dibenz(a,h)anthracene and benzo(a)pyrene — exceeded their respective industrial RBC in the upper interval.

Dibenz(a,h)anthracene was detected in six of 30 upper-interval samples with a range of 58 to 1,100 μg/kg and a mean of 278 μg/kg. One upper-interval sample (GDESB0180, 1,100 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Benzo(a)pyrene was detected in 15 of 30 upper-interval samples with a range of 82.0 to 3,100 μg/kg and a mean of 449 μg/kg. One upper-interval sample (GDESB018, 3,100 μg/kg) exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at supplemental sample locations. The BEQ was calculated in 16 upper-interval samples with a range of 0.0640 to 4,990 μg/kg and a mean of 629 μg/kg. Four samples (GDESB008, 826 μg/kg; GDESB010, 852 μg/kg; GDESB016, 782 μg/kg; and GDESB018, 4,987 μg/kg) exceeded the benzo(a)pyrene industrial RBC of 780.0 μg/kg.

Pesticides and PCBs in Soil

Eleven pesticides were detected in soil samples collected at supplemental sample locations. Twenty-nine detections occurred in the upper interval and seventeen in the lower interval. No pesticide exceeded its respective industrial RBC.

Two PCBs were detected in soil samples collected at supplemental sample locations. Three detections occurred in the upper interval and one in the lower interval. Neither PCB exceeded its respective industrial RBC.

Inorganic Elements in Soil

Twenty-five metals were detected at supplemental sample locations. Four hundred and ninety detections occurred in the upper interval and four hundred and sixty-one occurred in the lower interval. One metal — arsenic — exceeded both its respective industrial RBC and background RC in the upper interval. Additionally, arsenic also exceeded both its respective SSL and background RC in the lower interval.

Arsenic was detected in 23 of 30 upper-interval samples with a range of 1.30 to 67.5 mg/kg and a mean of 12.1 mg/kg. Three upper-interval samples (GDESB008, 23.9 mg/kg; GDESB010, 67.5 mg/kg; and GDESB018, 47.6 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg and background RC of 23.9 mg/kg. Arsenic was also detected in 23 of 28 lower-interval samples with a range of 0.830 to 29.4 mg/kg and a mean of 9.50 mg/kg. Four lower-interval samples (GDESB005, 22.6; GDESB008, 21.3; GDESB010, 26.3; and GDESB015, 23.6) exceeded both the arsenic SSL of 15 mg/kg and background RC of 19.9 mg/kg.

10.50.3 Groundwater Sampling and Analysis

Thirty deep monitoring wells and 30 shallow monitoring wells were installed and sampled to assess groundwater quality and to fill data gaps where site density decreased as shown in Figure 10.50.2. The wells were installed as follows:

- Shallow Wells — NBCEGDE001 through NBCEGDE030
- Deep Wells — NBCEGDE01D through NBCEGDE30D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, and TDS. Six samples were selected as duplicates and analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the suite of parameters proposed for supplemental samples plus a more comprehensive list of VOCs and SVOCs as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.50.3 summarizes groundwater sampling and analysis at supplemental monitoring wells.

Table 10.50.3
Supplemental Sampling
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	30	30	Standard Suite[a], chlorides, sulfates, and TDS	Standard Suite[a], chlorides, sulfates, and TDS	None
Deep	30	30	Standard Suite[a], chlorides, sulfates, and TDS	Standard Suite[a], chlorides, sulfates, and TDS	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring wells were installed at 12 to 16.6 feet bgs in the surficial aquifer. The deep wells were installed at 21.5 to 60.9 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.50.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow and deep groundwater are summarized in Tables 10.50.4.1 and 10.50.4.2, respectively. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.50.4.3 and 10.50.4.4, respectively. Appendix H is the complete data report for all samples collected in Zone E.

Table 10.50.4.1
Supplemental Sample Locations
Organic Compounds Detected in First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs (µg/L)						
Acetone	4/30	10.0 - 22.0	14.0	370	NA	0
Bromodichloromethane	1/30	2.00	2.00	0.170	100	1
Chloroform	2/30	1.000 - 13.0	7.00	0.150	100	2
1,1-Dichloroethene	1/30	2.00	2.00	0.0440	7.00	1
1,1,1-Trichloroethane	1/30	2.00	2	79.0	200	0
Trichloroethene	2/30	2.00 - 9.00	5.50	1.60	5.00	2
SVOCs (µg/L)						
Acenaphthene	1/30	1.000	1.000	220	NA	0
Benzoic acid	4/30	1.000 - 2.00	1.75	15,000	NA	0
bis(2-Ethylhexyl)phthalate	2/30	1.000 - 2.00	1.50	4.80	NA	0
4-Chloro-3-methylphenol	1/30	2.00	2.00	NA	NA	NA

Table 10.50.4.1
Supplemental Sample Locations
Organic Compounds Detected in First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs (µg/L)						
Diethylphthalate	1/30	2.00	2.00	2,900	NA	0
Fluorene	1/30	2.00	2.00	150	NA	0
4-Methylphenol (p-Cresol)	1/30	3.00	3.00	18.0	NA	0
4-Nitrophenol	1/30	1.000	1.000	230	NA	0
Pentachlorophenol	2/30	2.00 - 3.00	2.50	0.560	1.000	2
Pyrene	1/30	1.000	1.000	110	NA	0
Pesticides/PCBs (µg/L)						
Dieldrin	1/30	0.260	0.260	0.00420	NA	1
Heptachlor	1/30	0.0450	0.0450	0.00230	0.400	1
Dioxins (pg/L)						
Dioxin Equiv.	2/4	0.0608 - 0.377	0.219	0.430	NA	0
1234678-HpCDD	1/4	4.52	4.52	NA	NA	NA
1234678-HpCDF	2/4	2.88 - 6.08	4.48	NA	NA	NA
234678-HxCDF	1/4	2.43	2.43	NA	NA	NA
OCDD	1/4	56.8	56.8	NA	NA	NA
OCDF	1/4	3.19	3.19	NA	NA	NA
Engineering Parameters (SV)						
Chloride	20/30	3.40 - 4,000	1120	NA	NA	NA
pH	1/1	6.62	6.62	NA	NA	NA
Total Dissolved Solids (TDS)	23/30	180 - 7,500	2320	NA	NA	NA
Sulfate	11/30	9.90 - 493	99.1	NA	NA	NA

Notes:
µg/L = Micrograms per liter
pg/L = Picogram per liter
RBC = Risk-based concentration
NA = No RBC or MCL established
SV = Standard units

Table 10.50.4.2
Supplemental Sample Locations
Organic Compounds Detected in First Quarter Groundwater
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs (μg/L)						
Acetone	3/30	11.0 - 39.0	24.0	370	NA	0
Bromodichloromethane	1/30	2.00	2.00	0.170	100	1
Carbon disulfide	4/30	1.000 - 2.00	1.25	100	NA	0
1,1-Dichloroethene	1/30	2.00	2.00	0.0440	7.00	1
1,2-Dichloroethene (total)	6/30	3.00 - 56.0	25.8	5.50	70.0	4
4-Methyl-2-Pentanone (MIBK)	1/30	2.00	2.00	290	NA	0
Tetrachloroethene	2/30	5.00 - 63.0	34.0	1.10	5.00	2
Toluene	2/30	2.00 - 3.00	2.50	75.0	1,000	0
Trichloroethene	3/30	1.000 - 12.0	5.67	1.60	5.00	2
Xylene (Total)	1/30	2.00	2.00	1,200	10,000	0
SVOCs (μg/L)						
Acenaphthene	2/30	2.00 - 16.0	9.00	220	NA	0
Benzoic acid	4/30	1.000 - 4.00	1.75	15,000	NA	0
bis(2-Ethylhexyl)phthalate	6/30	1.000 - 89.0	34.8	4.80	NA	4
Butylbenzylphthalate	2/30	1.000 - 2.00	1.50	730	NA	0
Dibenzofuran	1/30	8.00	8.00	15.0	NA	0
Di-n-butylphthalate	2/30	1.000 - 10.0	5.50	370	NA	0
Diethylphthalate	1/30	1.000	1.000	2,900	NA	0
Fluorene	1/30	7.00	7.00	150	NA	0
2-Methylnaphthalene	1/30	54.0	54.0	150	NA	0
4-Methylphenol (p-Cresol)	1/30	2.00	2.00	18.0	NA	0
Naphthalene	1/30	3.00	3.00	150	NA	0
Phenanthrene	1/30	2.00	2.00	150	NA	0

Table 10.50.4.2
Supplemental Sample Locations
Organic Compounds Detected in First Quarter Groundwater
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
Dioxins (pg/L)						
Dioxin Equiv.	1/2	0.00800	0.00800	0.430	NA	0
OCDD	1/2	7.99	7.99	NA	NA	NA
Engineering Parameters (SV)						
Chloride	28/30	17.7 - 18,000	4,730	NA	NA	NA
Total Dissolved Solids (TDS)	29/30	288 - 32,500	8,620	NA	NA	NA
Sulfate	22/30	12.0 - 1460	344	NA	NA	NA

Notes:
µg/L = Micrograms per liter
pg/L = Picogram per liter
RBC = Risk-based concentration
NA = No RBC or MCL established
SV = Standard units

Table 10.50.4.3
Supplemental Sample Locations
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (µg/L)							
Aluminum (Al)	19/30	28.0 - 16,100	2,230	3,700	2,810	NA	4
Antimony (Sb)	3/30	2.10 - 4.90	3.67	1.50	NA	6.00	3
Arsenic (As)	14/30	3.60 - 316	42.8	0.0450	18.7	50.0	7
Barium (Ba)	11/30	17.6 - 312	79.2	260	211	2,000	1
Beryllium (Be)	3/30	0.350 - 0.850	0.530	0.0160	0.430	4.00	1
Calcium (Ca)	26/30	4,250 - 229,000	87,000	NA	NA	NA	NA
Chromium (Cr)	9/30	1.20 - 31.4	9.68	18.0	12.3	100	2

Table 10.50.4.3
Supplemental Sample Locations
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (µg/L)							
Cobalt (Co)	4/30	1.90 - 36.0	11.0	220	2.50	NA	0
Copper (Cu)	2/30	4.00 - 8.10	6.05	150	2.70	1,300	0
Cyanide (CN)	2/30	4.20 - 4.50	4.35	73.0	7.90	200	0
Iron (Fe)	28/30	359 - 70,900	10,600	NA	NA	NA	NA
Lead (Pb)	6/30	4.20 - 34.4	12.4	NA	4.80	15.0*	2
Magnesium (Mg)	26/30	2,380 - 224,000	55,700	NA	NA	NA	NA
Manganese (Mn)	25/30	6.70 - 2,560	439	84.0	2560	NA	1
Mercury (Hg)	4/30	0.160 - 0.610	0.293	1.10	NA	2.00	0
Nickel (Ni)	11/30	1.000 - 6.60	2.54	73.0	15.2	100	0
Potassium (K)	22/30	2,650 - 113,000	34,200	NA	NA	NA	NA
Selenium (Se)	2/30	3.40 - 5.20	4.30	18.0	NA	50.0	0
Sodium (Na)	19/30	5,210 - 2,560,000	830,000	NA	NA	NA	NA
Thallium (Tl)	1/30	5.30	5.30	0.290	5.40	2.00	0
Tin (Sn)	1/30	3.40	3.40	2,200	NA	NA	0
Vanadium (V)	24/30	0.960 - 26.0	5.88	26.0	11.4	NA	1
Zinc (Zn)	5/30	7.00 - 47.8	25.0	1,100	27.3	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference Concentration
NA = No RBC, RC or MCL established
* = TTAL

Table 10.50.4.4
Supplemental Sample Locations
Inorganic Detections for First Quarter Groundwater
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (µg/L)							
Aluminum (Al)	5/30	42.3 - 461	209	3,700	461	NA	0
Antimony (Sb)	2/30	4.50 - 6.80	5.65	1.50	NA	6.00	2
Arsenic (As)	12/30	2.80 - 77.5	18.0	0.0450	29.1	50.0	3
Barium (Ba)	14/30	12.4 - 322	76.0	260	322	2,000	1
Beryllium (Be)	4/30	0.310 - 1.000	0.510	0.0160	NA	4.00	4
Cadmium (Cd)	1/30	1.80	1.80	1.80	NA	5.00	1
Calcium (Ca)	29/30	45,800 - 332,000	157,000	NA	NA	NA	NA
Chromium (Cr)	5/30	1.50 - 2.00	1.74	18.0	2.00	100	0
Cobalt (Co)	5/30	1.40 - 14.2	6.74	220	14.2	NA	0
Copper (Cu)	2/30	2.60 - 2.70	2.65	150	NA	1,300	0
Cyanide (CN)	5/30	4.20 - 37.3	11.7	73.0	NA	200	0
Iron (Fe)	25/30	83.4 - 13,500	3,060	NA	NA	NA	NA
Magnesium (Mg)	29/30	3,330 - 1,370,000	299,000	NA	NA	NA	NA
Manganese (Mn)	28/30	48.8 - 834	270	84.0	944	NA	0
Mercury (Hg)	3/30	0.200	0.200	1.10	0.200	2.00	0
Nickel (Ni)	11/30	1.20 - 42.2	8.89	73.0	42.2	100	0
Potassium (K)	26/30	2,050 - 334,000	101,000	NA	NA	NA	NA
Silver (Ag)	1/30	2.70	2.70	18.0	NA	NA	0
Sodium (Na)	28/30	28,000 - 11,100,000	3,000,000	NA	NA	NA	NA
Thallium (Tl)	1/30	4.70	4.70	0.290	NA	2.00	1
Vanadium (V)	12/30	1.10 - 7.70	3.31	26.0	7.70	NA	0
Zinc (Zn)	4/30	4.70 - 21.4	11.9	1,100	21.4	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference Concentration
NA = No RBC, RC, or MCL established
SV = Standard units

Volatile Organic Compounds in Groundwater

Shallow Groundwater

Six VOCs were detected in shallow groundwater samples collected at supplemental sample locations. Four VOCs — bromodichloromethane, chloroform, 1,1-dichloroethene, and trichloroethene — exceeded their respective tap-water RBC.

Bromodichloromethane was detected in one well GDEGW03001 (2.0 μg/L) exceeding the bromodichloromethane tap-water RBC of 0.170 μg/L. The sample did not exceed the bromodichloromethane MCL of 100 μg/L.

Chloroform was detected in two of 30 samples with a range of 1.0 to 13.0 μg/L and a mean of 7.0 μg/L. Two samples from wells GDEGW02801 (1.0 μg/L) and GDEGW03001 (13.0 μg/L) exceeded the chloroform tap-water RBC of 0.150 μg/L. The samples did not exceed the chloroform MCL of 100 μg/L.

1,1-Dichloroethene was detected in well GDEGW02501 (2.0 μg/L) exceeding the 1,1-Dichloroethene tap-water RBC of 0.0440 μg/L. The sample did not exceed the 1,1-Dichloroethene MCL of 7.0 μg/L.

Trichloroethene was detected in two of 30 samples with a range of 2.0 to 9.0 μg/L and a mean of 5.50 μg/L. Two samples from wells GDEGW01701 (2.0 μg/L) and GDEGW02501 (9.0 μg/L) exceeded the trichloroethene tap-water RBC of 1.60 μg/L. The sample from well GDEGW02501 also exceeded the trichloroethene MCL of 5.0 μg/L.

Deep Groundwater

Ten VOCs were detected in deep groundwater samples collected at supplemental sample locations. Five VOCs — bromodichloromethane, 1,1-dichloroethene, 1,2-Dichloroethene (total), tetrachloroethene, and trichloroethene — exceeded their respective tap-water RBC.

Bromodichloromethane was detected in well GDEGW26D01 (2.0 μg/L) exceeding the bromodichloromethane RBC of 0.170 μg/kg. The sample did not exceed the bromodichloromethane MCL of 100 μg/L.

1,1-Dichloroethene was detected in well GDEGW17D01 (2.00 μg/L) exceeding the 1,1-dichloroethene RBC of 0.0440 μg/L. The sample did not exceed the 1,1-dichloroethene MCL of 7.0 μg/L.

1,2-Dichloroethene (total) was detected in six of 30 samples with a range of 3.00 to 56.0 μg/L and a mean of 25.8 μg/L. Four samples from wells GDEGW15D01 (9.0 μg/L), GDEGW17D01 (56.0 μg/L) GDEGW24D01 (28.0 μg/L), and GDEGW28D01 (54.0 μg/L), exceeded the 1,2-dichloroethene RBC of 5.50 μg/L. No sample exceeded the 1,2-dichloroethene (total) MCL of 70.0 μg/L.

Tetrachloroethene was detected in two of 30 samples with a range of 5.00 to 63.0 μg/L and a mean of 34.0 μg/L. Two samples from wells GDEGW17D01 (63.0 μg/L) and GDEGW26D01 (5.0 μg/L) exceeded the tetrachloroethene RBC of 1.10 μg/L. Both samples also exceeded the tetrachloroethene MCL of 5.0 μg/L.

Trichloroethene was detected in three of 30 samples with a range of 1.00 to 12.0 μg/L and a mean of 5.67 μg/L. Two samples from wells GDEGW17D01 (12.0 μg/L) and GDEGW26D01

(4.0 μg/L) exceeded the trichloroethene RBC of 1.60 μg/L. The sample from well GDEGW17D01 also exceeded the trichloroethene MCL of 5.0 μg/L.

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Ten SVOCs were detected in shallow groundwater samples collected at supplemental sample locations. One SVOC — pentachlorophenol — exceeded its respective tap-water RBC

Pentachlorophenol was detected in two of 30 samples with a range of 2.0 to 3.0 μg/L and a mean of 2.50 μg/L. Two samples from wells GDEGW01001 (3.0 μg/L) and GDEHW02501 (2.0 μg/L) exceeded the pentachlorophenol tap-water RBC of 0.560 μg/L. Both samples also exceeded the pentachlorophenol MCL of 1.0 μg/L.

Deep Groundwater

Twelve SVOCs were detected in deep groundwater samples collected at supplemental sample locations. One SVOC — BEHP — exceeded its respective tap-water RBC.

BEHP was detected in six of 30 samples with a range of 1.0 to 89.0 μg/L and a mean of 34.8 μg/L. Four samples from wells GDEGW03D01 (89.0 μg/L), GDEGW07D01 (70.0 μg/L), GDEGW15D01 (40.0 μg/L), and GDEGW30D01 (7.0 μg/L) exceeded the BEHP RBC of 4.80 μg/L. No MCL has been established for BEHP.

Pesticides and PCBs in Groundwater

Shallow Groundwater

Two pesticides were detected in shallow groundwater samples collected at supplemental sample locations. Both pesticides — dieldrin and heptachlor — exceeded their respective tap-water RBC at one location.

Dieldrin was detected in well GDEGW02801 (0.26 μg/L) exceeding its tap-water RBC of 0.0042 μg/L. No MCL has been established for dieldrin.

Heptachlor was detected in well GDEGW00101 (0.045 μg/L) exceeding its tap-water RBC of 0.0023 μg/L. The sample did not exceed the heptachlor MCL of 0.400 μg/L.

Other Organic Compounds in Groundwater

Shallow Groundwater

Five dioxins were detected in shallow groundwater samples collected at supplemental sample locations. No tap-water RBCs or MCLs have established for these parameters.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for collected samples. The TEQ was calculated for two samples with a range of 0.0608 to 0.377 pg/L and a mean of 0.219 pg/L, below the 2,3,7,8-TCDD tap-water RBC of 0.430 pg/L. No MCL has been established for the dioxin equivalent.

Deep Groundwater

One dioxin was detected in deep groundwater samples collected at supplemental sample locations. No tap-water RBC or MCL has been established for the parameter.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for collected samples. The TEQ was calculated for one sample at 0.008 pg/L below the 2,3,7,8-TCDD tap-water RBC of 0.430 pg/L. No MCL has been established for the dioxin equivalent.

Inorganic Elements in Groundwater

Shallow Groundwater

Twenty-three metals were detected in shallow groundwater samples collected at supplemental sample locations. Nine metals — aluminum, antimony, arsenic, barium, beryllium, chromium, lead, manganese, and vanadium — exceeded both their respective tap-water RBC and shallow groundwater background RC.

Aluminum was detected in 19 of 30 samples with a range of 28.0 to 16,100 μg/L and a mean of 2,230 μg/L. Four samples from wells GDEGW01901 (3,710 μg/L), GDEGW02601 (16,100 μg/L), GDEGW02801 (7,040 μg/L), and GDEGW02901 (7,540 μg/L) exceeded both the aluminum tap-water RBC of 3,700 μg/L and RC of 2,810 μg/L. No MCL has been established for aluminum.

Antimony was detected in three of 30 samples with a range of 2.10 to 4.90 μg/L and a mean of 3.67 μg/L. Three samples from wells GDEGW01801 (2.1 μg/L), GDEGW01901 (4.0 μg/L), and GDEGW02401 (4.9 μg/L) exceeded the antimony tap-water RBC of 1.50 μg/L; no RC has been established for antimony. No sample exceeded the antimony MCL of 6.0 μg/L.

Arsenic was detected in 14 of 30 samples with a range of 3.60 to 316 μg/L and a mean of 42.8 μg/L. Seven samples from wells GDEGW00201 (316 μg/L), GDEGW00301 (51.7 μg/L), GDEGW00601 (18.7 μg/L), GDEGW00801 (56.3 μg/L), GDEGW01601 (55.8 μg/L), GDEGW02701 (23.3 μg/L), and GDEGW02901 (20.5 μg/L) exceeded both the arsenic tap-water RBC of 0.0450 μg/L and RC of 18.7 μg/L. Samples GDEGW00201, GDEGW00301, GDEGW00801, and GDEGW01601 also exceeded the arsenic MCL of 50.0 μg/L.

Barium was detected in 11 of 30 samples with a range of 17.6 to 312 μg/L and a mean of 79.2 μg/L. One sample from well GDEGW01201 (312 μg/L) exceeded both the barium tap-water

RBC of 260 μg/L and RC of 211 μg/L. The sample did not exceed the barium MCL of 2,000 μg/L.

Beryllium was detected in three of 30 samples with a range of 0.350 to 0.850 μg/L and a mean of 0.530 μg/L. One sample from well GDEGW02601 (0.85 μg/L) exceeded both the beryllium tap-water RBC of 0.016 μg/L and RC of 0.43 μg/L. The sample did not exceed the beryllium MCL of 4.0 μg/L.

Chromium was detected in nine of 30 samples with a range of 1.20 to 31.4 μg/L and a mean of 9.68 μg/L. Two samples from wells GDEGW02601 (22.1 μg/L) and GDEGW02801 (31.4 μg/L) exceeded both the chromium tap-water TTAL of 18.0 μg/L and RC of 12.3 μg/L.

Lead was detected in six of 30 samples with a range of 4.20 to 34.4 μg/L and a mean of 12.4 μg/L. Two samples from wells GDEGW02401 (34.4 μg/L) and GDEGW02601 (20.8 μg/L) exceeded both the lead tap-water RBC of 15.0 μg/L and RC of 4.8 μg/L. Both samples also exceeded the lead MCL of 15.0 μg/L.

Manganese was detected in 25 of 30 samples with a range of 6.70 to 2,560 μg/L and a mean of 439 μg/L. One sample from well GDEGW00901 (2,560 μg/L) exceeded both the manganese tap-water RBC of 84.0 μg/L and RC of 2,560 μg/L. No MCL has been established for manganese.

Vanadium was detected in 24 of 30 samples with a range of 0.960 to 26.0 μg/L and a mean of 5.88 μg/L. One sample from well GDEGW02601 (26 μg/L) exceeded both the vanadium tap-water RBC of 26.0 μg/L and RC of 11.4 μg/L. No MCL has been established for vanadium.

Deep Groundwater

Twenty-two metals were detected in deep groundwater samples collected at supplemental sampling locations. Six metals — antimony, arsenic, barium, beryllium, cadmium, and thallium — exceeded both their respective tap-water RBC and deep groundwater background RC.

Antimony was detected in two of 30 samples with a range of 4.50 to 6.80 μg/L and a mean of 5.65 μg/L. Two samples from wells GDEGW10D01 (4.5 μg/L) and GDEGW19D01 (6.8 μg/L) exceeded the antimony tap-water RBC of 1.50 μg/L; no RC has been established for antimony. The sample from well GDEGW19D01 also exceeded the antimony MCL of 6.0 μg/L.

Arsenic was detected in 12 of 30 samples with a range of 2.80 to 77.5 μg/L and a mean of 18.0 μg/L. Three samples from wells GDEGW09D01 (77.5 μg/L), GDEGW15D01 (29.1 μg/L), and GDEGW29D01 (32.0 μg/L) exceeded both the arsenic tap-water RBC of 0.045 μg/L and RC of 29.1 μg/L. The sample from well GDEGW09D01 also exceeded the arsenic MCL of 50.0 μg/L.

Barium was detected in 14 of 30 samples with a range of 12.4 to 322 μg/L and a mean of 76.0 μg/L. One sample from well GDEGW23D01 (322 μg/L) exceeded the barium tap-water RBC of 260 μg/L and equaled the RC of 322 μg/L. The sample did not exceed the barium MCL of 2,000 μg/L.

Beryllium was detected in four of 30 samples with a range of 0.310 to 1.0 μg/L and a mean of 0.510 μg/L. Four samples from wells GDEGW05D01 (1.0 μg/L), GDEGW18D01 (0.31 μg/L), GDEGW27D01 (0.36 μg/L), and GDEGW30D01 (0.37 μg/L) exceeded the beryllium tap-water RBC of 0.0160 μg/L; no RC has been established for beryllium. No sample exceeded the beryllium MCL of 4.0 μg/L.

Cadmium was detected in one of 30 samples at 1.80 μg/L. One sample from well GDEGW04D01 (1.8 μg/L) exceeded the cadmium tap-water RBC of 1.8 μg/L; no RC has been established for cadmium. The sample did not exceed the cadmium MCL of 5.0 μg/L.

Thallium was detected in one of 30 samples at 4.70 μg/L. One sample from well GDEGW15D01 (4.70 μg/L) exceeded the thallium tap-water RBC of 0.290 μg/L; no RC has been established for thallium. The sample also exceeded the thallium MCL of 2.0 μg/L.

10.50.5 Fate and Transport Assessment

To help characterize background conditions and provide data points where site-specific data are missing, supplemental soil and groundwater samples were collected throughout Zone E. Migration pathways were not assessed for soil and groundwater samples collected at supplemental locations, however, results from several locations were incorporated into site-specific assessments.

10.50.6 Human Health Risk Assessment

A formal risk assessment was not conducted for supplemental sample locations. Results from several supplemental locations were incorporated into site-specific assessments to further delineate sites and aid in the risk assessment process.

10.50.7 Corrective Measures Considerations

Corrective measures were not considered for supplemental locations, however, contamination identified at supplemental locations will be further addressed in the CMS for Zone E.